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PERCEPTUAL DETERMINANTS OF CROWDING STRESS

by

© THOMAS E. JOHNSON

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

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FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "Perceptual Determinants of Crowding Stress" submitted by Thomas E. Johnson in partial fulfilment of the requirements for the degree of Master of Science in Psychology.

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ABSTRACT

Recent perspectives concerning the determinants of perceived crowding have viewed this experience as some function of spatial, social, and personal parameters. However, there is currently no precise theoretical understanding of the mechanisms that underlie this experience, nor is there a clear empirical basis for predicting the relative influence of personal and situational factors in mediating the experience of crowding under varying environmental circumstances. It is the thesis of the present analysis that these failures to specify the critical determinants of crowding stress can be attributed to the absence of a conceptually adequate definition of the environment. Two studies were conducted to assess the manner in which the environment is perceived by individuals, and the factors or dimensions of the environment that may be important for engendering perceptions of crowding. In the first study, subjects judged paired comparisons of the importance of environmental factors that have been presumed to engender perceptions of crowding. Multidimensional scaling techniques were used to examine the perceptual-cognitive dimensions employed by individuals in evaluating crowded environmental settings. Based on findings of Experiment 1, the second study was conducted to assess the importance of the perceptual-cognitive dimensions identified

in Experiment 1, for individuals' experience of a crowded environmental setting. In this study, subjects performed a vigilance task under distracting noise conditions. Spatial density (room size) and social density (number of subjects per group) were held constant across experimental conditions, while a personal factor, perceived control over noise exposure with four levels, was assigned between groups of subjects. Consistent with previous crowding formulations, analysis of subjects' responses in both the scaling study and experimental study revealed that the experience of crowding appears to be a function of spatial, social, and personal parameters that interact to determine the relative salience to the individual of cues associated with spatial and social density. Moreover, the results indicated that a personal factor, perceived control over the environment, appears to be the critical factor that determines the extent to which cues associated with dense environments will be experienced as stressing or benign. Furthermore, both performance and questionnaire measures revealed that perceptions of control over one aversive aspect of the environment appear to be effective in reducing the impact of other sources of stress in the environment that are not directly controllable, or perceived as controllable. These findings were interpreted as supporting an interactionist perspective that emphasizes the interaction of personal and environmental factors in determining behavior. The results

were discussed with respect to their implications for behavior-theoretic and motivational models of crowding, and with respect to their implications for the direction of future crowding research.

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TABLE OF CONTENTS

PAGE

INTRODUCTION 1

STUDY I 17

Method 17

Subjects 17

Stimuli 17

Procedure 19

Analysis 21

Results 24

Discussion 34

STUDY II 37

Method 37

Subjects and Design 37

Apparatus and Stimuli 37

Procedure 38

Dependent Measures 42

Results 45

Discussion 60

GENERAL DISCUSSION 67

REFERENCES 73

REFERENCE NOTES 79

APPENDIX 1. Experimental Questionnaire for Study I 80

APPENDIX 2. Instructions for Vigilance Task 83

APPENDIX 3. Instructions for Frustration Tolerance Task and Puzzle Diagrams 86

APPENDIX 4. Feeling Tone Check List 88

APPENDIX 5. Experimental Questionnaire for Study II 89

APPENDIX 6. Analysis of Subjects' Ratings of Perceived Control Over Noise Exposure 96

APPENDIX 7A. Summary of Analysis of Subjects' Reaction Times for Dial Signal 4 97

APPENDIX 7B. Summary of Analysis of Subjects' Reaction Times for Dial Signal 5 98

APPENDIX 8. Summary of Analysis of Subjects' Fatigue Ratings 99

APPENDIX 9. Summary of Analysis of Subjects' Mean Noise Annoyance Ratings of 20 Noise Stimuli 100

APPENDIX 10. Summary of Analysis of Subjects' Puzzle Attempts for the First Insoluble Puzzle 101

APPENDIX 11. Summary of Analysis of Subjects' Ratings of Confinement 102

APPENDIX 12. Analysis of Subjects' Ratings of the Extent to which They Were Anxious for the Vigilance Task to End 103

APPENDIX 13A. Summary of Analysis of Subjects' Ratings of Overall Noise Annoyance During the Vigilance Task 104

APPENDIX 13B. Post-hoc Analysis of Overall Noise Annoyance Ratings with No Control and Group Avoidance Conditions Combined 105

APPENDIX 14. Summary of Post-hoc Analysis of Subjects' Ratings of Perceived Comfort 106

APPENDIX 15A. Varimax Rotated Factor Matrix 107

APPENDIX 15B. Oblique Factor Pattern 108

APPENDIX 15C. Oblique Factor Correlations 109

APPENDIX 16. Summary of Factor Score Analysis for Factor V 110

LIST OF TABLES

Table	Description	Page
1	Paired-Comparison Stimuli: Experiment 1	20
2	Normalized Stimulus Coordinates on Unroated INDSCAL Dimensions	28
3	Average Dimension Weights for Males and Females	33
4	Factor Analysis Item Pool	55
5	Principal Factor Solution: Loadings for Factor I	56
6	Principal Factor Solution: Loadings for Factor II and Factor III	57
7	Varimax Solution Factor Loadings	58

LIST OF FIGURES

Figure		Page
1	INDSCAL configuration for 15 environmental stimuli: Dimension I vs. Dimension II	26
2	INDSCAL configuration for 15 environmental stimuli: Dimension I vs. Dimension III	27
3	Subjects' ratings of perceived control over noise exposure as a function of experimental conditions	48

INTRODUCTION

The increased saliency of urban stressors as a social issue has generated a growing amount of research in the area of environment-behavior interactions. A central focus of much of this research has been the attempt to delineate the effects of density and crowding on social and psychological functioning. On the basis of the extreme negative social and physiological consequences of high density observed in animal populations (cf. Calhoun, 1962; Christian, Flyger & Davis, 1960), it has typically been assumed in analyses of human crowding that combinations of increasing population density and restrictions of physical space bear a direct relationship to perceptions of crowding and consequent social and psychological stress. Moreover, high levels of density have been hypothesized to affect mental health and disease, crime, social disorganization (Schmitt, 1957, 1966), attraction and liking for others (Griffitt & Veitch, 1971), avoidance of social interaction and withdrawal from social contact (Valins & Baum, 1973; Baum & Valins, 1973), aggression (Freedman, Levy, & Buchanan, 1972; Hutt & Vaizely, 1966; Loo, 1973), central nervous system functioning (Esser, 1973), and task performance (Freedman, Klevansky, & Ehrlich, 1971; Freedman, Levy, Buchanan, & Price, 1972; Sherrod, 1974). In contrast to the presumed stress inducing effects of density on social and

psychological functioning, the empirical evidence however, offers little support for these assumptions, and for the most part has been inconsistent and inconclusive (Freedman, 1972; Lawrence, 1974; Stokols, Rall, Pinner & Schopler, 1973). As a consequence, recent conceptualizations concerning the determinants of crowding have evidenced a shift from a stimulus-response view to an interactionist perspective (cf. Bowers, 1973; Stokols, 1976) that emphasizes the interaction of personal and environmental factors in determining behavior. Central to this perspective is the role of perceptual and cognitive factors in affecting the response to environmental contingencies, and similarly in mediating behavioral outcomes that have functional significance for the individual (Altman, 1975; Stokols, 1972a).

While a number of recent analyses have implicated the role of cognitive and perceptual factors in either mitigating or intensifiying the experience of crowding (cf. Altman, 1975; Sherrod, 1974; Stokols, 1972a; Sundstrom, 1975; Worchel & Teddle, 1976), there is currently no precise theoretical understanding of the mechanisms that underlie this experience. Nor is there a clear empirical basis for predicting the relative influence of personal and situational factors in mediating the experience of crowding under varying environmental circumstances. Moreover, the recurrent inability to equate observed differences in

individual stress reactions with objectively measured differences in the level of environmental stress, precludes the ability to provide conceptual restraints in the absence of a unifying theoretical crowding framework. It is the thesis of the present analysis that these failures stem from a conceptually inadequate definition of the environment and the concomitant neglect of researchers to specify and control certain essential stimulus dimensions that may be important determinants of psychological stress in behavior settings. In evidence of this neglect is the apparent unsystematic manner in which spatial, nonspatial, or some arbitrary combination of these variables, have been hypothesized to effect behavior without any seeming basis in empirical fact.

The recurrent failure to confirm expectations concerning the effects of density and crowding on behavior led a number of investigators to reexamine the initial conceptualization of the crowding hypothesis. Consistent with an interactionist perspective, Proshansky, Ittelson, and Rivilin (1970) suggested that the physical environment was perhaps more complex than previously construed. As a consequence, they suggested that sustained systematic empirical research concerning the relationships of the individual to the environment was needed in order to identify the circumstances which promote a sense of being crowded. Central to this endeavor was the need to define and

elaborate existing man-environment concepts, and in addition, to determine the role of the physical environment in structuring the experience and behavior of the individual in the environmental setting.

In elaborating this view, Proshansky (1973) suggested that the behavior and experience of the individual evolve from the interaction of the actual physical characteristics of the setting and the individual's experience of the setting. In turn, environmental settings were viewed as having normative properties that structure the individual's behavior and experience along a number of structural and substantive dimensions that give a sense of meaning or identity to the individual in relation to specific environments. Thus environmental settings were characterized as varying along physical, psychological, and social dimensions that elicit, structure, and give meaning to experience and behavior. In the context of crowding, early formulations which characterized crowding as a unidimensional phenomena with an easily identifiable class of physical referents were too simplistic to capture the complex phenomena that mediate the experience of crowding. As a consequence, the inconsistent empirical evidence concerning the effects of density and crowding on behavior could be attributed to a failure on the part of researchers to abstract essential environment-behavior dimensions, and to maintain the integrity of the physical setting in terms

of its dimensional complexity. Accordingly, Proshansky considered the fundamental task of the environmental psychologist as conceptualizing the environment in a manner that emphasized the dimensional complexity of the physical setting. Further to these considerations, Proshansky emphasized the need to establish linkages between environment and behavior concepts by relating them to, and interrelating them with, existing social-psychological theory.

Following the programatic statements of Proshansky et al. (1970) a number of crowding models emerged (Altman, 1975; Esser 1971, 1972, 1973; Stokols, 1972a, 1972b, 1976; Sundstrom, 1975; Zlutnick & Altman, 1972) that attempted to delineate the experience of crowding in terms of antecedent events, personal factors, and behavioral outcomes. Distinguishing these models from earlier crowding formulations was the characterization of crowding as a psychological as well as an objectively viewed social phenomena. For instance in Stokols' formulation (1972b) density was seen as a physical condition involving a restriction or limitation of available space, while crowding was viewed as an experiential state in which the restrictive aspects of the spatial environment related to others and the space available are perceived by the individual as stressing. On the basis of this distinction density was viewed as a necessary antecedent but not sufficient

condition for the experience of crowding. In order for density to become aversive certain other factors must be present that influence the individual's demand for space. Stokols suggested that these factors include the type of activity occuring in the setting, the perceived adequacy of available space, as well as personal dispositions of the individual such as his past experience and his ability to cope with the stressing aspects of the situation.

Similar ideas were offered by others. Altman (1975) described crowding as a sequential regulatory process in which desired privacy is thwarted by a breakdown of interpersonal boundaries. Whether or not the experience of crowding results in response to environmental circumstances will depend on certain antecedent factors that contribute to desired and achieved levels of privacy, cognitive and perceptual responses of the individual that monitor the situation, and overt coping behaviors of the individual that attempt to achieve or restore desired levels of privacy. In a similar formulation, Sundstrom (1975) viewed crowding as a sequential interpersonal process in which crowding stress results from a failure of the individual to enact successful coping behaviors in order to compensate for social overstimulation. Consistent with the formulations of Altman and Stokols, psychological factors were seen to mediate antecedent spatial and social conditions which in turn motivated the individual to restore psychological or spatial

equilibrium to the setting. To the extent that this sequential process resulted in desired levels of stimulation, the experience of crowding did not result. Conversely, the inability of the individual to make certain adjustments to either augment his available space (Stokols, 1972a) or to adjust certain social or personal variables in order to minimize situational constraints (Altman, 1975; Sundstrom, 1975), resulted in a stress syndrome which engendered the experience of crowding.

Each of the above analyses is consistent in viewing crowding as some function of spatial, personal, and social parameters. However the critical stimulus factors that underlie these dimensions have not been precisely determined. In addressing this issue, Stokols (1972b) argued that the direct assessment of crowding parameters could be determined by the orthogonal manipulation of variables relating to spatial, social, and personal variables. However, in a subsequent attempt to examine the relative contribution of spatial and non-spatial components in engendering the experience of crowding, Stokols, Rall, Pinner and Schopler (1973) found little support for their assumptions. Results of their study indicated that subjects generally reported feeling more crowded in a small room than in a large room. However, no effect of room size and task set was revealed, with subjects in the cooperative task set reporting more confinement than competitive subjects. In

addition, density manipulations revealed no effect on stress measures including task performance, enjoyment, liking or hostility toward others, or feelings of relatedness to the group. This result led Stokols et al. to conclude that the experience of crowding does not appear to automatically lead to negative behavorial effects.

In addition to the findings of Stokols et al., other studies have been consistent in demonstrating only weak stress reactions to density manipulations. In one series of studies, Freedman, Klevensky, and Ehrlich (1971) failed to find evidence that density affects task performance. In each of three studies no effects on task performance were observed due to differences in density or group size, with subjects performing equally well under conditions of high and low density for both simple and complex tasks. In a second set of studies Freedman, Levy, Buchanan, and Price (1972) found evidence for an interaction effect of sex and room size on competitiveness, severity of sentencing by a jury, and liking for others. However, this pattern of findings did not obtain for mixed sex groups and, in the absence of a main effect of roomsize, led Freedman et al. to attribute this finding to other situational factors.

More recently, Sherrod (1974) has provided evidence that cognitive factors appear to interact with spatial constraints in mediating stress reactions to density manipulations. In an extension of Glass and Singer's (1972)

work on the aversive effects of unpredictable noise exposure on task performance, Sherrod reasoned that crowding might entail negative postcrowding consequences analogous to those observed to aversive noise exposure. For instance, Glass and his associates (Finkelman & Glass, 1970) observed that aversive noise appeared to affect complex task performance which was concurrent with noise exposure. However, performance on simple tasks was unaffected by noise exposure apparently due to subjects' ability to sucessfully adapt to the stressing aspects of noise. More significant was the finding that subjects exposed to unpredictable or uncontrollable noise did, however, exhibit postnoise performance impairments. Thus while subjects were able to adapt to the stressing aspects of noise during noise exposure, the negative consequences of aversive noise emerged on post noise behaviors. In addition, Glass and Singer observed that these negative effects on task performance were reduced if noise exposure was predictable or controllable as opposed to unpredictable or uncontrollable. Moreover, subjects who only believed that they could control noise exposure, when in fact control was not possible, exhibited fewer postnoise performance decrements than subjects who did not perceive control over noise exposure. On the basis of these findings, Sherrod argued that cognitive factors, or the idividuals' perception of control over aversive aspects of crowding, may be effective in mediating the response to crowding stress. In

turn, the consistent lack of crowding findings may have been due to the ability of individuals to adapt to the stressing aspects of density manipulations.

In a subsequent test of these assumptions, Sherrod found no significant differences in task performance in any of three conditions of crowding. However, postcrowding measures revealed that subjects who were led to believe that they could escape from a crowded room, persisted longer at a frustration tolerance task than crowded subjects who could not escape. Consistent with conclusions of Glass and Singer, Sherrod interpreted these findings as support for the assumption that crowding appears to have deleterious behavioral aftereffects which may be ameliorated by the cognitive context in which crowding occurs. Presumably, perceptions of lack of control over environmental circumstances intensify the impact of crowding stress. Conversely, perceptions of environmental control minimize the stressful aspects of crowding.

Other evidence that the effects of room density may vary as a function of the effectiveness of interpersonal coping responses was provided in a recent experiment by Sundstrom (1975). In this study designed to assess the effects of density, goal blocking, and intrusion on individual control over interpersonal interactions, Sundstrom observed that subjects reported feeling significantly less comfortable and more crowded in a small

room than in a large room. In addition, it was revealed that for subjects in the small room, reported comfort increased over time while crowding scores evidenced a decrease as the experiment progressed, suggesting that subjects were able to adapt to the stressing aspects of the small room. Similarly, stress associated with intrusion evidenced a decrease over time. Moreover, two affiliative behaviors, facial regard and intimacy of self-disclosure, revealed interactions consistent with predictions that stress is intensified when intrusion and goal blocking occur in high room density. However, more direct measures of stress failed to exhibit the expected interactions. In summarizing these results, Sundstrom suggested that high room density appears to entail interpersonal disturbances such as intrusion and goal blocking which in turn may lead to the experience of stress. However, coping responses may be effective in reducing this stress.

In summary, laboratory studies have shown only weak or mixed reactions to density manipulations. Moreover, the extant research demonstrates that individuals can function quite well on complex tasks even under conditions of high density. However, the factors that contribute to these findings remain unclear. For instance, Freedman (1973) and Stokols et al. (1973) suggest that high density does not automatically lead to negative behavorial effects. Conversely, the findings of Sherrod (1974) and Sundstrom

(1975) suggest that individuals may adapt to the stressing aspects of density but that postcrowding consequences may result. Similarly, findings provided by Sundstrom suggest that personal variables such as unwanted stimulation may have more reliable negative effects on stress than density. Thus, while the presumed stress enhancing effects of density on behavior appear complex, the extant findings fail to provide a clear indication of the factors that contribute to this complexity. Specifically, while it appears that crowding stress may be intensified under conditions of spatial constraint, other situational and personal factors appear to interact with spatial variables to mitigate the experience of crowding stress. To date, neither the critical spatial variables that mediate perceptions of constraint, nor the personal or situational factors that act to determine the extent to which crowding stress is experienced have been identified.

In general, existing research has demonstrated the importance of integrating both social and spatial factors in crowding formulations. However, the failure to specify more adequately the critical determinants of crowding stress becomes understandable in the absence of a conceptually adequate definition of the environment. While a number of theorists (Barker, 1968; Craik, 1970; Ittleson, 1973; Lewin, 1936; Proshansky, 1973; Tolman, 1938) have attempted to provide frameworks for conceptualizing the

interrelationships of man and environment, the physical environment has received very little systematic attention. As a consequence, there is a paucity of data regarding the manner in which the environment is perceived by individuals, or what factors or dimensions of the environment are important for human behavior. In the context of crowding, this inability to specify the critical stimulus features of the environment that may engender crowding stress, makes it difficult to determine whether existing findings are due to adaptation effects or, conversely, to the possibility that crowding manipulations may have been non-stressing due to their lack of salience to the individual.

Clearly more research is needed in order to delineate the phenomenology of crowding and the role of the physical environment in structuring the individual's behavior and experience in the crowded environment. The critical issues of this research concern the systematic definition and elaboration of the complexity or dimensionality of man-environment interactions, and the establishment of the empirical referents that promote a sense of being crowded. Given this emphasis on the complexity of the environment, a major task of this research is not only to identify the critical spatial, social, and personal variables that give rise to the experience of crowding, but moreover, to attempt to establish the interrelations of these dimensions. This task necessitates linking the individual's perceptual and

cognitive organization of the crowded environment to its physical referents. In this manner, it becomes possible to specify both the critical stimulus dimensions that promote the experience of crowding, and, in addition, the range of behaviors that may have functional significance for the alleviation of crowding stress. As noted by Proshansky (1973), this "searching out" of dimensions implies exploratory and descriptive investigations which are noticably absent in the extant crowding research.

To begin to address some of these issues, two studies were conducted in order to specify more adequately the nature of the environmental stimulus domain, and to assess the relative saliency to the individual of previously hypothesized crowding antecedents. The purpose of Experiment I was to map the dimensionality of the environmental stimulus domain as it relates to the experience of crowding. In this study subjects judged paired comparisons of the importance of environmental factors that have been presumed to engender perceptions of crowding. Of specific interest in this study were the perceptual-cognitive dimensions employed by individuals in evaluating crowded environmental settings, and, secondly, whether these perceptual-cognitive dimensions appeared to be invariant with respect to different individuals. To assess the nature of these cognitive dimensions, multidimensional scaling techniques were employed to examine the patterns of subjects' ratings to 15

environmental stimuli that have been hypothesized to engender perceptions of crowding. Finally, the extent to which males and females differed in their perceptions of the stimulus features was examined in order to assess the perceptual invariance of these dimensions.

Based on findings of Experiment I, a second experiment was conducted in order to assess the importance of the perceptual-cognitive dimensions identified in Experiment I, for the individual's perceptions of crowding. In this study, subjects performed a vigilance task under distracting noise conditions and a postnoise frustration tolerance task. Spatial density (room size) and social density (number of subjects per group) were held constant across experimental conditions, while a personal factor, perceived control over noise exposure with four levels, was assigned between groups of subjects. The major aim of Study II was to assess the extent to which individuals' perceptions of control over aversive aspects of the environment are related to task performance, noise adaptation, perceptions of crowding, and negative affect.

Based upon results of Study I that suggested that perceptions of control over aversive aspects of the environment may mitigate stress reactions, it was anticipated that increasing perceptions of control over annoying noise exposure would result in decreasing levels of negative affect and increased levels of task performance.

Thus, it was expected that perceived control manipulations would differentiate subjects in terms of task performance, perceived noise annoyance, perceptions of the experiment, and perceptions of other group members. The general hypothesis advanced and tested in Experiment II states that both performance decrements and measures of negative affect will be a decreasing linear function of perceived control over noise exposure.

STUDY I

METHOD

Subjects

The subjects were 58 females and 57 male undergraduates who participated as volunteers at the request of the experimenter conducting an environmental concerns survey. Approximately equal numbers of subjects provided questionnaire responses in one of two testing sessions held in a lecture hall. Each session contained approximately equal proportions of males and females.

Stimuli

The initial problem of the study was to derive a set of environmental stimuli that appeared to characterize the important stimulus features of the crowded environment. In the absence of a well formulated theory of the environment, it was considered expedient to proceed by examining aspects of the environment that have been hypothesized to mediate perceptions of crowding. In general, it was felt that these variables should reflect major aspects of the spatial, social, and psychological dimensions that may operate in the context of the crowded environment to promote the experience of crowding.

A review of the spatial factors that have been hypothesized to affect perceptions of environmental settings revealed that room size may be an important factor in

crowding (Freedman et al., 1971), or more generally, the type and availability of space (Stokols et al., 1973), and the existence of partitions or barriers (Stokols, Smith, & Prostor, 1975). In addition, the work of Glass and Singer (1972) and Kryter (1970) suggest that ambient noise levels within a setting may have important psychological consequences. Similarly, the effective temperature of a setting may promote physical and psychological discomfort (Baron, 1972; Griffitt & Veitch, 1971). Other important spatial factors may include the visual complexity of the setting, such as the number of signs, colors, light levels, landscaping, and visibility of people (Kutner, 1975; Rapoport, 1975), as well as the level of attractive stimuli in the setting (Lipowski, 1971).

Turning to the social factors of a setting, Milgram (1970) has suggested that type and level of social interaction may result in a social overload which is characterized as a stress syndrome. High levels of social interaction may be the result of task complexity (Freedman et al., 1971; Glass & Singer, 1972), the type of interaction such as cooperation or competition (Stokols et al., 1973), unwanted or excessive social interaction (Valins & Baum, 1973; Sundstrom, 1975), or an undermanned or overmanned environmental setting (Barker, 1968; Wicker, 1973). In addition, Stokols (1975) has suggested that the inability to avoid social interaction may importantly mediate perceptions

of crowding.

The most critical personal factor hypothesized to mediate perceptions of crowding appears to be perceived control, or an individual's feelings of control in relation to the environment (Glass & Singer, 1972; Finkelman & Glass, 1970; Lefcourt, 1973; Sherrod, 1974). Presumably, feelings of lack of control, choice, or freedom in a setting or in relation to an aversive stimulus, will affect evaluations of the setting and may be associated with increased stress. To the extent that an individual perceives himself to be at the mercy of environmental circumstances the threat of the stressor may be intensified. Similarly, perceptions of control in relation to the environment are seen to affect appraisal of the stressor in reducing its impact. In turn, perceived control may be mediated by the homogenity of the group in relation to common values, behavior patterns, communication systems, culture, age, and sex (Rapoport, 1975), or by the perceived ability to avoid the stimulus either by leaving the setting or by means of some instrumental response of the individual (Glass & Singer, 1972).

Finally, examination of these factors resulted in the 15 environmental stimuli of Table 1.

Procedure

The objective of Study I was to relate the variables of

Table 1

Paired-Comparison Stimuli: Experiment I

1.	Setting size
2.	Setting Decor (barriers, amount of furniture, etc.)
3.	Noise level
4.	Temperature
5.	Number of visual objects (signs, posters, etc.)
6.	Attractiveness of setting (colors, landscaping etc.)
7.	The difficulty of your activity
8.	Lighting levels (dark, well-lighted, etc.)
9.	Type of activity
10.	Your goal
11.	Having to interact with others
12.	The number of other people
13.	Your familarity with the setting
14.	The length of time you spend in the setting
15.	The type of people (sex, age, nationality, etc.)

Table 1 as distances in a multidimensional stimulus space. The subjects' task was to make direct judgments of the similarity between pairs of the 15 environmental stimuli. Specifically, subjects were asked to rate each pair of stimuli in terms of "how similar in importance" the stimuli appeared for engendering the experience of crowding. Ratings were made on a 9-point rating scale, where a rating of 1 refered to "not at all similar in importance" and a rating

of 9 refered to "extremely similar in importance." To control for possible order effects, each subject received one of 10 different random orderings of the stimulus pairs. Instructions to subjects and response formats are presented in Appendix 1. Time taken to complete the questionnaire averaged about 20 minutes.

Analysis

In order to approximate the presumed psychological spatial configuration and concomitantly, to capture the full complexity of the data, distance scaling techniques were employed that allow the representation of the environmental stimuli as objects in a t-dimensional space. Dimensionality estimates for these data were obtained from a non-metric analysis of the subjects' proximity judgments using Kruskal's (1964a, b) method of multidimensional scaling. In Kruskal's formulation the distance between any two stimuli, say x_i and x_j, is represented in Euclidian space by a function of the form

$$x_i - x_j = d_{ij} = \left(\sum_{r=1}^{t} (x_{ir} - x_{jr})^2 \right)^{\frac{1}{2}} \qquad (1)$$

where d_{ij} corresponds to the distance from x_i to x_j, and t corresponds to the dimensionality of the configuration. Essentially what is sought is a spatial configuration of the smallest possible dimension such that the computed interpoint distances between the stimuli d_{ij} are monotonically related to the original proximity measures

such that $d_{ij} \leq d_{kl}$ whenever $x_{ij} < x_{kl}$. Using Kruskal's method, dimensionality is estimated by computing a value termed "stress" which measures departures from monotonicity according to the equation

$$\text{stress} = \left(\sum_{i<j} (d_{ij} - \hat{d}_{ij})^2 \Big/ \sum_{i<j} d^2 \right)^{\frac{1}{2}} \qquad (2)$$

where d_{ij} represents the reconstructed distances of the proximities data and $\hat{d}_{ij}$ represents the computed distances that minimize the sum of squared deviations subject to the constraint of monotonicity with the original proximity measures. Accordingly, dimensionality is specified when a minimum stress value is obtained.

Following determination of minimum dimensionality, proximity measures were scaled using INDSCAL (Carroll & Chang, 1970) which is a metric procedure for analyzing individual differences in multidimensional configurations. The advantage of using INDSCAL in making group comparisons is that it allows determination of the relative salience, or weight, of a given dimension for every subject. Conceptually, it is assumed that the dimensionality of a solution represents the fundamental attributes of the stimuli, but that subjects may still vary individually as to the relative weighting or importance which they attach to a given dimension. In terms of the present analysis, this technique makes it possible to assess the relative salience of a given dimension for a given individual or group of

individuals, and in addition, allows comparison of different environmental stimuli relative to a common set of dimensions.

Essentially, INDSCAL relates subjects' proximities as distances in t-dimensional space by a function of the form

$$d_{jk}^{(i)} = \left(\sum_{t=1}^{r} w_{it} \left(x_{jt} - x_{kt} \right)^2 \right)^{\frac{1}{2}} \qquad (3)$$

where $d_{jk}^{(i)}$ represents the distance between stimulus values x_j and x_k for individual i, w_{it} is the weight attached to dimension t for individual i, and x_{jt} and x_{kt} represent distances on dimension t in Euclidian spatial coordinates. Given normalization of the group configuration such that the sum of squared coordinates on each stimulus dimension is set equal to 1, the square of an individual's weight on a particular dimension indicates the proportion of variance accounted for in that subject's proximity data by that dimension. Finally, scale values for the 15 environmental stimuli on each of the three INDSCAL dimensions were hierarchically clustered using Johnson's (1967) diameter method. The result is to produce minimum variance spherical clusters that provide an operational classification of the environmental stimuli. This method was employed to provide objectively defined clusters of the stimuli to use as an aid in interpreting the final INDSCAL configuration.

RESULTS

As outlined, subjects' proximity measures were submitted to a nonmetric analysis using Kruskal's method (1964a, b). and dimensionality estimates were recovered in descending steps from 10 to 1 dimensions. Comparison of Kruskal's stress measure for each of the resulting configurations suggested subjects' original proximity data could best be approximated in 3 dimensions (stress = .084).

The original proximity measures were subsequently input to INDSCAL and scale values were recovered in 3 dimensions. Scale values were found to be highly correlated with the average proximity measures ($r = .87$), accounting for approximately 76% of the variance in the group responses. This result suggested a good fit of these data. In order to assess the reliability of this solution, subjects were randomly devided into 10 subgroups and average proximity measures were scaled in 3 dimensions using a number of different starting configurations. The average subgroup correlation coefficient over all solutions was found to be .75. Similarly, correlation of subgroup scale values from these different solutions revealed a high degree of correspondence (average inter-solution correlation coefficient = .88), indicating that a reliable solution for these data had been obtained. Finally, an oblique transformation of the initial three dimensional Kruskal solution to the final INDSCAL configuration using the

Procrustes method (Schonemann, 1966), revealed that the two solutions were highly congruent (Tucker coefficient = .95).

The projections of the 15 environmental stimuli on the final INDSCAL dimensions are presented in Table 2, and depicted graphically in Figures 1 and 2 together with the results of the cluster analysis. The seven clusters that emerged from this analysis corresponded to seven of the eight octants of the three dimensional space. Examination of the unrotated configuration revealed three evaluative or perceptual dimensions which accounted for 68%, 20%, and 12% respectively of the total variation accounted for in subjects' original proximity measures. These three dimensions appear to be best characterized as psychological continuums which partition the stimulus configuration into clearly distinguishable clusters of personal, social, and spatial features of the environment. Thus, on the basis of these data, spatial aspects of the environment appear to be organized in perception in terms of the visual and sensory cues that they provide to the individual. For example, visual cues are indicated by the cluster containing the items "visual objects," "attractiveness of the setting," and "setting decor," and by the cluster that contains "lighting level." Sensory cues are represented by the cluster containing the items, "noise" and "temperature," pertaining to levels of auditory and thermal stimulation. With respect to crowding, combinations of visual and sensory cues

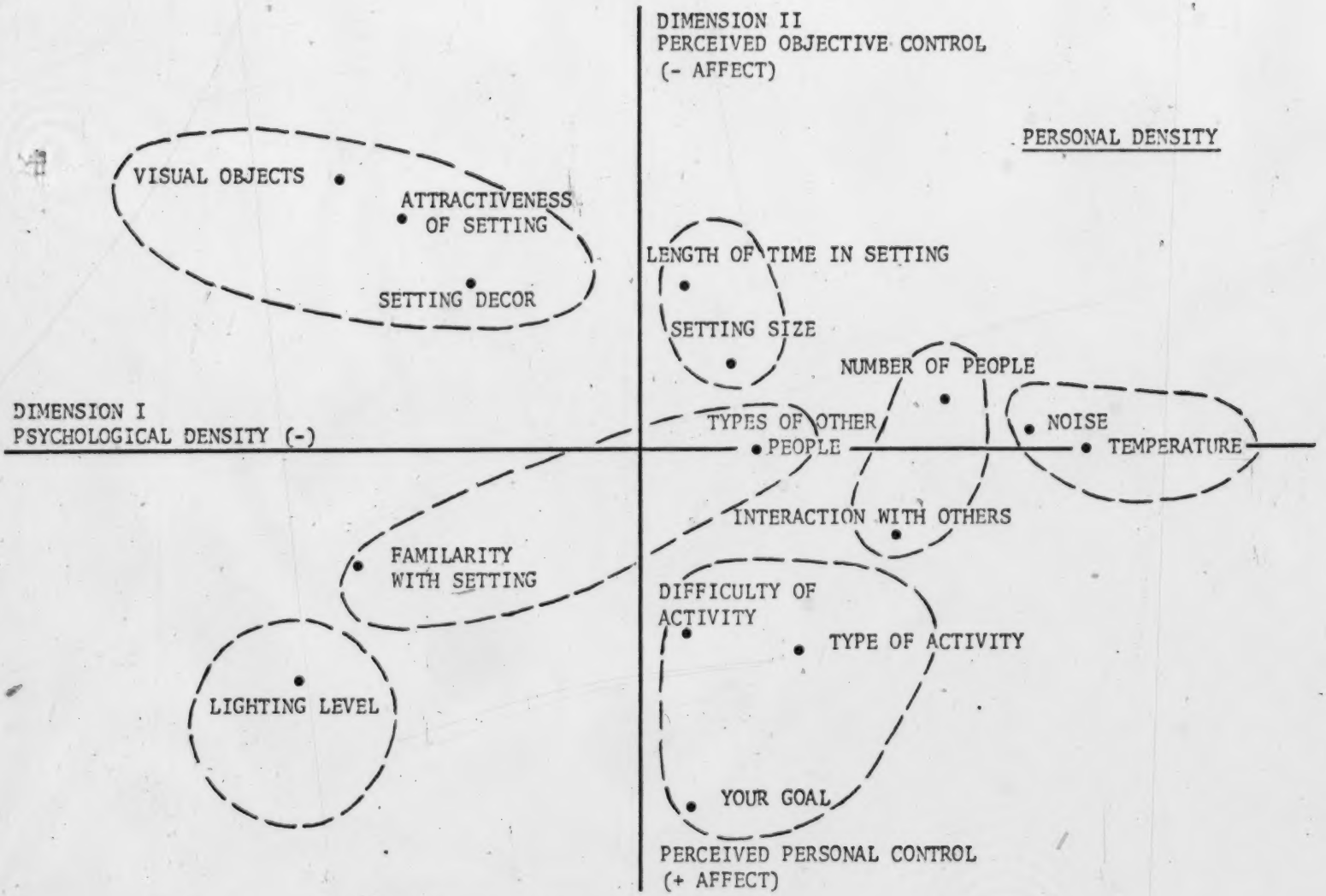

Figure 1. INDSCAL configuration for 15 environmental stimuli: Dimension I vs. Dimension II

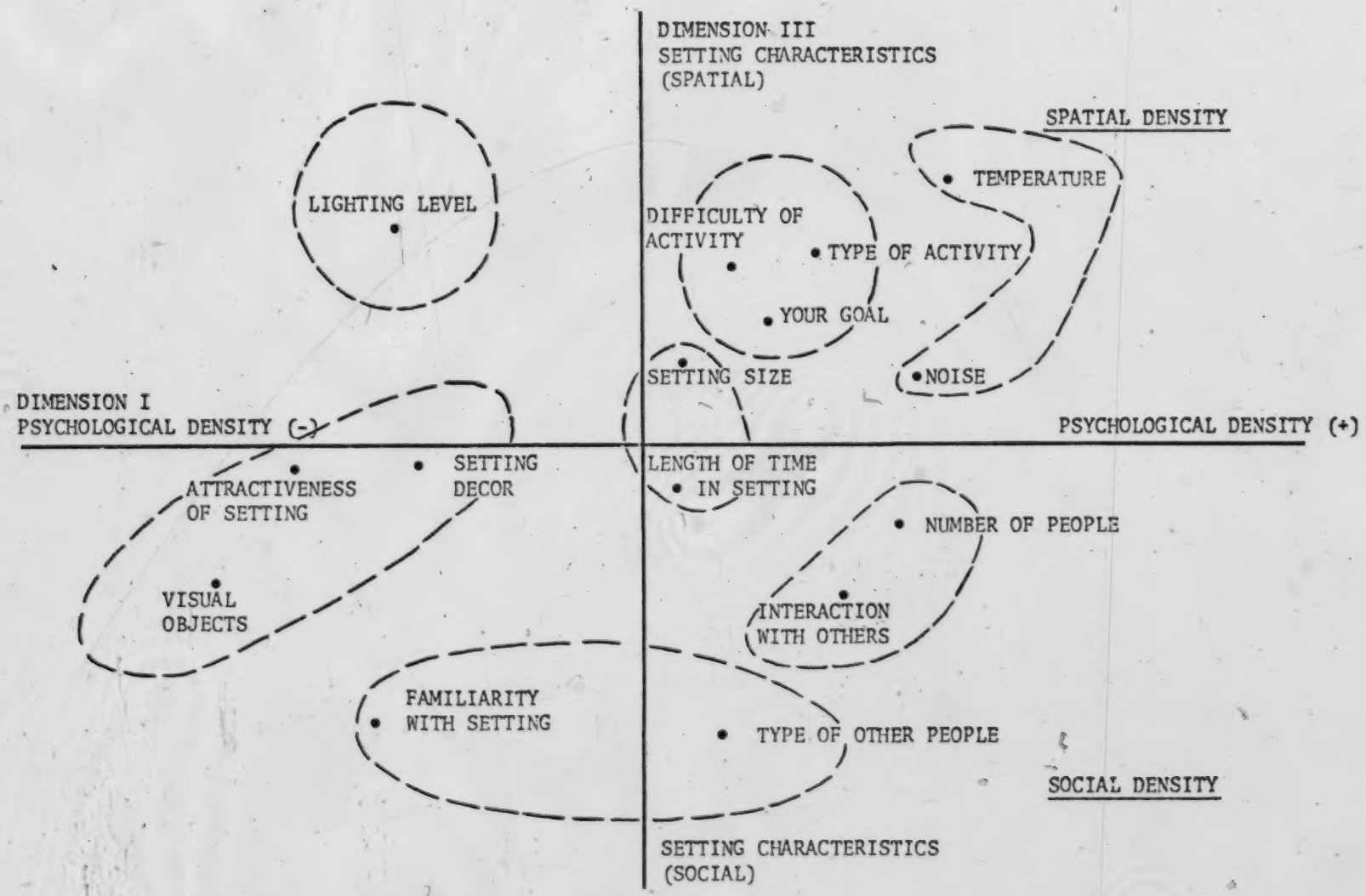

Figure 2. INDSCAL configuration for 15 environmental stimuli: Dimension I vs. Dimension III.

Table 2

Normalized Stimulus Coordinates
on Unroted INDSCAL dimensions

STIMULI	DIM. 1	DIM. 2	DIM. 3
1. Lighting Levels	-.340	-.289	.396*
2. Setting Size	.046	.106	.103
3. Setting Decore	-.277	.337*	-.052
4. Noise Level	.322*	.050	.109
5. Temperature	.343*	.002	.355*
6. Number of Visual Objects	-.417	.443*	-.127
7. Your Goal	.113	-.472	.174
8. Attractiveness of Setting	-.370	.378*	-.052
9. Type of Activity	.170	-.262	.229
10. Interaction with Others	.193	-.166	-.215
11. Number of Other People	.246	.058	-.136
12. Familarity with Setting	-.315	-.162	-.326
13. Length of Time in Setting	.033	.176	-.098
14. Difficulty of Activity	.147	-.284	.235
15. The Type of People	.106	.006	-.596
Percentage of Variance	52%	15%	9%

Coordinates one standard deviation above the mean (.26) are starred. Coordinates one standard deviation below the mean (-.26) are underlined.

associated with the spatial environment may indicate to the individual the relative levels of comfort afforded by the setting, and in addition, provide cues related to the presence and numbers of others.

Social aspects of the environment appear to be represented by the two clusters related to activities and to interactions with others. Thus cues provided by the type and difficulty of activity, together with the individual's goal in the setting may suggest levels of social density to the individual. For instance, perceptions concerning the complexity of a given task, or the spatial requirements of the task, may provide cues related to the actual or potential spatial restrictions of performing a given activity in a limited amount of space. Similar cues regarding potential levels of social interaction are suggested by the cluster containing the items, "interaction with others," and "number of people." These cues which are related to the number of people in the setting, appear to be evaluated with respect to whether or not the individual must interact in some manner with others. Thus, the perception of the potential social and spatial restrictions associated with a large number of other people may be offset by the individual's anticipation of low levels of interaction with others. Conversely, few, relative to large numbers of others, may be perceived as providing a more spatially restrictive setting in situations where interaction is anticipated by the individual.

Cues that appear to provide information more immediately related to personal factors of the person-environment interaction are suggested by the cluster

containing the items, "familiarity with setting," and "type of people," and the cluster containing "setting size" and "length of time in the setting." Presumably, less spatial restrictiveness will be perceived in familiar settings with well known others or friends, than in less familiar settings with unknown others. Similarly, perceptions of spatial restriction associated with the size of the setting appear to depend in part on the individual's knowledge concerning the amount of time that will be spent in the setting. Thus, cues associated with the limited space provided by a spatially dense setting should be less salient to the individual when the setting will be experienced for only limited amounts of time.

While these patterns of cluster relations can be viewed as providing information concerning the relative levels of density associated with personal, social, and spatial aspects of the setting, a more accurate representation of these patterns might focus on the interactions of these cue relations. Thus, while setting size and length of time in the setting can be viewed as personal cues in the sense that the individual evaluates spatial features of the environment in terms of personal dispositions, these cues also provide information more immediately related to spatial restrictiveness. Similarly, perceived levels of task difficulty and type of activity, relating to more social aspects of the setting, are evaluated with respect to the

individual's personal goal. Thus, perceptions of crowding appear to be represented as a joint function of spatial, social, and personal parameters. Paralleling this expectation is the finding that the three dimensions of the present solution exhibit moderate intercorrelations (average correlation coefficient = .30), suggesting that the cluster relations which emerged here were viewed by individuals as interrelated. In order to preserve this complexity, and to explore more fully the cognitive-perceptual organization of cues associated with the crowded environment, cluster relations can be further viewed with respect to their factorial complexity within the three dimensional perceptual space. In this perspective, item clusters appear related to the three dimensions in a manner which suggests that certain combinations of environmental factors mediate evaluations of spatial, social, or personal density as indicated by the respective quadrant labels of Figures 1 and 2.

For instance, Dimension I appears to represent the continuum of psychological density moving from uncrowded to crowded, as characterized by the relative presence or absence of certain critical stimulus features. For instance, increasing combinations of such factors as noise, temperature, and numbers of people are perceived as reflecting more intense levels of psychological density than are combinations of visual objects or variations in setting decor.

Similarly, dimension II, labeled perceived control, is characterized by item clusters which appear to mediate perceptions of personal or objective control over the environment. As can be observed in Figure 1, the presence of certain environmental features that suggest little environmental control, such as the number of people, noise level, or setting size, suggests a more intense experience of psychological density, which in turn may predispose the individual to feel crowded. This is characterized as a state of personal density as represented by the first quadrant of Figure 1. Conversely, factors related to an individual's goal or his interaction with others and which are more immediately under personal control, may act to mitigate perceptions of density.

Dimension III, depicted in Figure 2, appears to represent the continuum of setting characteristics evidenced by those environmental features that suggest combinations of spatial and social density. Presumably, increasing combinations of social and spatial factors interact to imply less personal control over the environment and, concomitantly, greater levels of psychological density.

Weights

A further purpose of the analysis was to compare the respective dimension weights of males and females in order to estimate the importance or salience attached to these

dimensions by each subgroup. To investigate these differences, additional scalings were derived from the original set of similarity ratings for males and females. Table 3 provides evidence for variation in the conceptual structures for males and females. As can be observed, the

Table 3

Average Dimension Weights for Males and Females

Subgroup	N	Dimension 1 "Psychological Density"	Dimension 2 "Perceived Control"	Dimension 3 "Setting Characteristics"
1. Male	57	.75*	.29	.27
2. Female	58	.59*	.41	.29

* Starred weights differ significantly at the .05 level of significance.

average weight for males is significantly higher on dimension I than the average weight observed for females (critical t-diff. = 12.54, 44 df, $p < .05$). Given that dimension I represents the continuum of psychological density as mediated by increasing levels of such factors as noise, temperature, and numbers of people, this result would tend to suggest that females may tolerate higher levels of density before perceiving themselves as crowded than do males. While tentative, this result is consistent with other findings that suggest females are less competitive and less aggressive under crowded conditions than are males, (Freedman et al., 1972; Stokols et al., 1973) and similarly,

exhibit less physiological arousal to crowded conditions than do males (Epstein & Aiello, 1974).

In contrast, weights on the perceived control dimension are somewhat higher for females than for males, but not reliably so (critical t-diff. = 13.5, 44df, $p>.05$). However, the somewhat larger weighting exhibited by females on this dimension may suggest that perceptions of control over the environment are slightly more salient for females.

Finally the weights attached to the dimension of setting characteristics suggest that this dimension is perceived as equally important by both groups.

DISCUSSION

In general, results of the present analysis suggest that the experience of crowding appears to depend upon two classes of antecedents. The first class consists of those features of the environment which serve as cues to signify to the individual the relative levels of social and spatial density in the setting. The second class consists of the psychological evaluative processes of the individual by which these environmental features are appraised as stressing or not stressing depending upon the individual's perception of control in the setting. Presumably, conditions of high spatial and social density in combination with little perceived control over the environment will result in

a state of personal density or feelings of crowdedness. Conversely, situations that appear spatially or socially dense but suggest perceptions of control, possibly by means of escape or some form of avoidance behavior, will result in lower levels of psychological density reflecting uncrowded states. Given this relationship between density and the evaluative process, these results suggest that perceived control as mediated by an individual's ability to avoid or escape the stressing aspects of the environment, appears to be the critical determinant for the experience of crowding.

In general, these findings are consistent with a number of other crowding formulations which suggest that perceptions of crowding are some function of spatial, social, and personal parameters. However, the present findings would seem to extend earlier formulations by implicating perceived control as the critical parameter in mediating the effects of both spatial and social variables. In addition, the finding that male-female differences in the relative perceptual structuring of these dimensions appear consistent with previous findings offers further support for the present interpretation. Taken as a whole, the results of the present analysis suggest that individual perceptions of the important determinants of crowding are relatively invariant with respect to the major dimensions that appear to operate in the crowded environment, but that the relative salience of these dimensions may vary to some extent with

the personal dispositions of the individual.

In order to test these assumptions and to empirically demonstrate the validity of Experiment I, a second study was conducted in order to examine the influence of various levels of personal and objective control on perceptions of crowding.

STUDY II

METHOD

Subjects and design

The subjects were 120 male introductory psychology students who participated in the study in partial fulfillment of a course requirement. Six groups of subjects (n = 5) were nested randomly within each of four levels of the perceived control factor.

Apparatus and stimuli

The apparatus for the study consisted of 20 rectangular Simpson AC volt meters mounted into three 4 ft. X 6 ft. (1.22 m X 1.83 m) wood panels. Each panel contained two rows of dials. Dials were spaced such that the center of each dial was separated by 19 in. (.48 m) within rows and 22 in. (.56 m) between rows. Two of the panels contained seven dials and were mounted on the sides of the room; the remaining panel contained six dials and was mounted on the front of the room. Panels were mounted on the walls such that the top row of dials was at a height above the floor of 63 in. (1.6 m) while the bottom row of dials was at a height above the floor of 40 in. (1.2m).

The auditory stimulation consisted of random intermittant 350 Hz squarewave bursts generated by a function generator (Exact Electronics Corporation) and recorded on magnetic tape. Taped noise stimulation was

presented to the right ear through high-fidelity earphones in bursts of 3, 6, 9, or 12 sec. at an intensity of 95 dBA. Randomization of the tape was achieved by dividing each minute of the task into 15 second intervals and assigning one noise burst to one of the randomly selected intervals. Noise burst duration was also randomized. Each of the four noise burst durations was replicated five times resulting in 2 minutes and 30 seconds of noise on the 21 minute tape. The tape began with 1 minute of silence.

Reaction times for each subject were recorded using electronic timers (Lafayette Instrument Company).

Procedure

Subjects arrived at the experiment in unaquainted groups of five expecting to participate in a human vigilance study. Upon their arrival, each subject received a clipboard containing a number of noise scales and an adjective checklist to be used during the experiment. Subjects were then escorted to the experimental room where they were informed that the aim of the experiment was to study the performance of routine tasks under distracting conditions. The experimental room was an area of approximately 46 sq. ft. (4.3 m^2) containing no furniture with the exception of the three wood panels containing the dial gauges, five sets of earphones, and five sets of pushbutton switches suspended from one of the panels.

After instructing subjects on the proper use of the earphones and the hand held push-button switches, the experimenter introduced the vigilance task by reading a standard set of instructions.[1] The vigilance task was similar to the "Twenty Dials Task" developed by Broadbent (1950, 1951, 1954). On the face of each dial was a continuously moving pointer and an area marked in red which was designated as the "danger zone." Subjects were instructed that they must detect any pointer reading in the danger zone by activating a hand held push button switch. After all five of the subjects had registered a detection, the pointer was reset to the normal level. Subjects received a total of six signals during the 20 minute vigilance task. Signal onset was held constant across conditions such that signals were always presented at times 2.5, 7, 9, 14, 15.5 and 19 minutes respectively after the start of the vigilance task.

After ensuring that all subjects understood the instructions for the vigilance task, the experimenter continued with instructions concerning the noise bursts and noise annoyance rating scales. Subjects were instructed that they would hear a number of noises during the vigilance task "that might sound somewhat annoying." Whenever subjects

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1 The complete set of instructions for the vigilance task, together with the variations which comprised the experimental manipulations, are contained in Appendix 2.

heard one of these noises they were required to make a category rating of their perceived annoyance of the noise burst on a 7-point not at all annoying-extremely annoying scale. During the vigilance task, subjects were presented with a total of 20 random intermittant 350-Hz squarewave bursts. Noise presentation and dial signal onset were synchronized so that signal presentation was never concurrent with noise presentation.

After answering subjects' questions concerning details of the vigilance task and noise rating instructions, the experimenter then carried out the perceived control manipulation. Perceived control over noise was manipulated by varying the extent to which individual subjects believed that they were personally able to avoid noise exposure. Thus in the escape condition, subjects were provided with the following instruction adapted for use from Glass and Singer (1972, p. 64): "If you want, you can turn off the noise you will be hearing by unplugging your earphones . . . . Of course, whether or not you choose to turn off the noise is up to you. Some people who are in the study do in fact elect to turn off the noise; others do not. We would prefer that you do not, but that's entirely up to you."[2] This level represented the highest level of personal control. The

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2 Consistent with previous experiments which have used this instruction, no subject elected to unplug his earphones during the vigilance task.

second level of personal control, termed personal avoidance, was manipulated by instructing subjects that the detection of a dial signal within 2 seconds after stimulus onset would terminate noise presentation for the remainder of that trial for that individual. In contrast, the third level of control, group avoidance, was manipulated by instructing subjects that noise termination on a partiuclar trial was contingent on the entire group of subjects detecting the onset of the stimulus within 4 seconds. Finally, the last level of control, termed no control, was manipulated by informing subjects that while other groups in the experiment had been able to avoid noise exposure by reacting to the stimulus within 2 seconds, this was not possible in the present study. Thus no control subjects were sensitized to their lack of control relative to other subjects. This last condition, while not a control group per se, served to anchor the control continuum which ranged from the absence of personal control (no control), through intermediate levels of control (group avoidance; personal avoidance), to complete personal control (escape).

Following termination of the vigilance task, but before leaving the experimental room, subjects responded to the Feeling Tone Check List (Pearson & Byars, 1957) which is a checklist for measuring subjective fatigue. Upon completion of this scale, subjects were ushered back into the 15 ft. X 19 ft. (4.57 m X 5.79 m) waiting room and seated in

individual desks. Desks were spaced throughout the room such that no individual was seated within 6 ft. (1.8m) of any other individual. Here, subjects worked on a frustration tolerance task and completed the experimental questionnaire which contained the main dependent measures of the study. All subjects were then fully debriefed and thanked for their participation.

Dependent Measures

The dependent measures included both performance and affective measures designed to assess subjects' perceptions and manifestations of crowding stress.

Performance Measures

Vigilance task.

Performance on the vigilance task was indicated by subjects' reaction times to each of the six dial signals. Fast reaction times relative to slow reaction times were taken to reflect higher levels of performance. Because missed signals occured infrequently, missing values were estimated by using the geometric mean of the individual's remaining scores.

Frustration tolerance.

The post-vigilance task was similar to that used by Glass and Singer (1972) and required that subjects trace over the lines of each of four diagrams (see Appendix 3 for task instructions and diagrams) without tracing any line

twice, and without lifting the pencil from the figure. Two of the four puzzles (Puzzles 1 and 3) were insoluble but sufficiently complex so that subjects could not detect this. Puzzle performance was timed such that at the end of each 2 minute trial subjects had to choose to try a new puzzle, or re-attempt the puzzle that they were currently working on. The measure of persistence, or the number of attempts at solving an insoluble puzzle was taken to reflect the subject's level of frustration tolerance.

Affective Measures

Noise annoyance.

Subjects' perceived annoyance of the noise stimuli was indicated by their rating of each stimulus on a 7-point not at all annoying - extremely annoying catagory rating scale. Each subject's mean category rating over the 20 noise trials served as a measure of his overall level of perceived noise annoyance. The subject's mean score for each of 5 blocks of 4 noise trials served as a measure of cognitive adaptation to noise.

Subjective fatigue.

Based on the possibility that crowding stress may include a fatigue component, the 13 item Feeling Tone Check List (Pearson & Byars, 1957; Appendix 4) was included as a measure of subjective fatigue.

Experimental questionnaire.

The experimental questionnaire (Appendix 5) consisted of 9-point bi-polar rating scales designed to assess subjects' perceptions of crowding, comfort, anxiety, enjoyment of the experiment, and perceptions of other group members. The items associated with perceptions of crowding were: not at all crowded-extremely crowded, free to move-restricted; and the experimental room: spacious-confined, adequate-inadequate, not stuffy-stuffy, cold-hot. Subjects' comfort and anxiety were assessed with the following items: relaxed-tense, comfortable-uncomfortable, not frustrated-frustrated, not stressed-stressed, passive-aggressive, not upset-upset, not anxious for task to end-anxious for task to end, and patient-impatient. With respect to their enjoyment of the experiment, subjects responded to the two items, unenjoyable-enjoyable and boring-interesting. Perceptions of other group members were indicated by responses to three items: friendly-hostile, passive-aggressive, and likable-unlikable. Finally, subjects indicated their overall level of noise annoyance and puzzle task frustration on the two items, not at all annoying-extremely annoying, and not at all frustrating-extremely frustrating.

Manipulation check items.

Subjects' perceptions of control over noise exposure were checked with the following item: "To what extent did you feel you could have had the noise stopped during the

dial reading task?" (felt I had no control at all over noise - felt I had complete control over noise). In addition, subjects in the group avoidance and personal avoidance conditions were asked to rate the extent to which their performance on the dial reading task enabled them to avoid some of the noise (did not at all enable me to avoid some noise-completely enabled me to avoid some noise). Finally, subjects in the escape condition were asked to rate how free they felt to unplug their earphones (not at all free-extremely free).

In addition to these manipulation check items, all subjects rated the overall similarity of their previous work experience to the vigilance task (not at all similar-extremely similar), and reported the number of people in their immediate family. These last two items were included in the questionnaire to be used as covariates in the analyses.

RESULTS

Data Analysis

The responses of the 120 subjects on each of the dependent measures were analyzed in a single-factor analysis of variance with groups of subjects nested within each of the four levels of the perceived control factor.[3] A similar analysis of variance was performed on subjects' factor scores which were derived from a principal factor analysis of affective measures contained on the post experimental

questionnaire.

Preliminary analyses of the two items, similarity of previous work experience and number of persons in immediate family, failed to reveal significant between group differences for the control variable. Consequently, all analyses reported below are without covariates.

Effect of Manipulation

The effectiveness of the perceived control manipulation was assessed by having subjects rate the extent to which they felt that they could have had the noise stopped during the dial reading task. In addition, subjects in the group avoidance and personal avoidance conditions were asked to rate the extent to which their performance on the dial reading task enabled them to avoid some of the noise. Analysis of subjects' responses on the perceived control measure (Appendix 6) indicated a significant main effect for control ($F=8.09$, df 3/116, $p<.01$) which was consistent with the predicted ordering among the four means. The significant main effect for control, however, was qualified by a Duncan's Multiple Range Test which revealed that only the escape condition differed significantly from the remaining

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3 A nested analyses of variance of these data revealed no systematic differences due to the groups factor (F ratio consistently < 1; df 20/96). Consequently, the error term employed in the analyses consisted of the pooled sums of squares for groups within treatments and subjects within groups X treatments, divided by the pooled degrees of freedom.

perceived control conditions ($p<.05$). The means for the experimental conditions are shown graphically in Fig. 3. Consistent with these data, analysis of responses on the ability to avoid noise measure for the personal avoidance and group avoidance conditions revealed identical levels of perceived ability to avoid noise exposure ($\underline{M}1 = \underline{M}2=3.4$, $F=.004$, df 1/58, $p>.95$). Thus the perceived control manipulation was only partially sucessful.

Vigilance Task Performance

In order to assess performance on the vigilance task, subjects' reaction times to each of the six dial signals were transformed to a reciprocal scale (Edwards, 1972, p.107). Analysis of each measure revealed a significant main effect for control only on reaction time trial 4 ($F=2.67$, df 3/116, $p<.05$) and trial 5 ($F=2.94$, df 3/116, $p<.05$). Multiple comparisons among the means by the Duncan's Multiple Range Test revealed that subjects in the personal avoidance condition responded significantly faster than subjects in the no control condition on trial 4 ($p<.05$); while group avoidance subjects responded significantly faster on trial 5 than did subjects in the remaining perceived control conditions ($p<.05$). These analyses are summarized in Appendix 7.

Finally, a repeated measures analysis with perceived control as the between-group factor and trials as the within-group factor, revealed no significant effect of

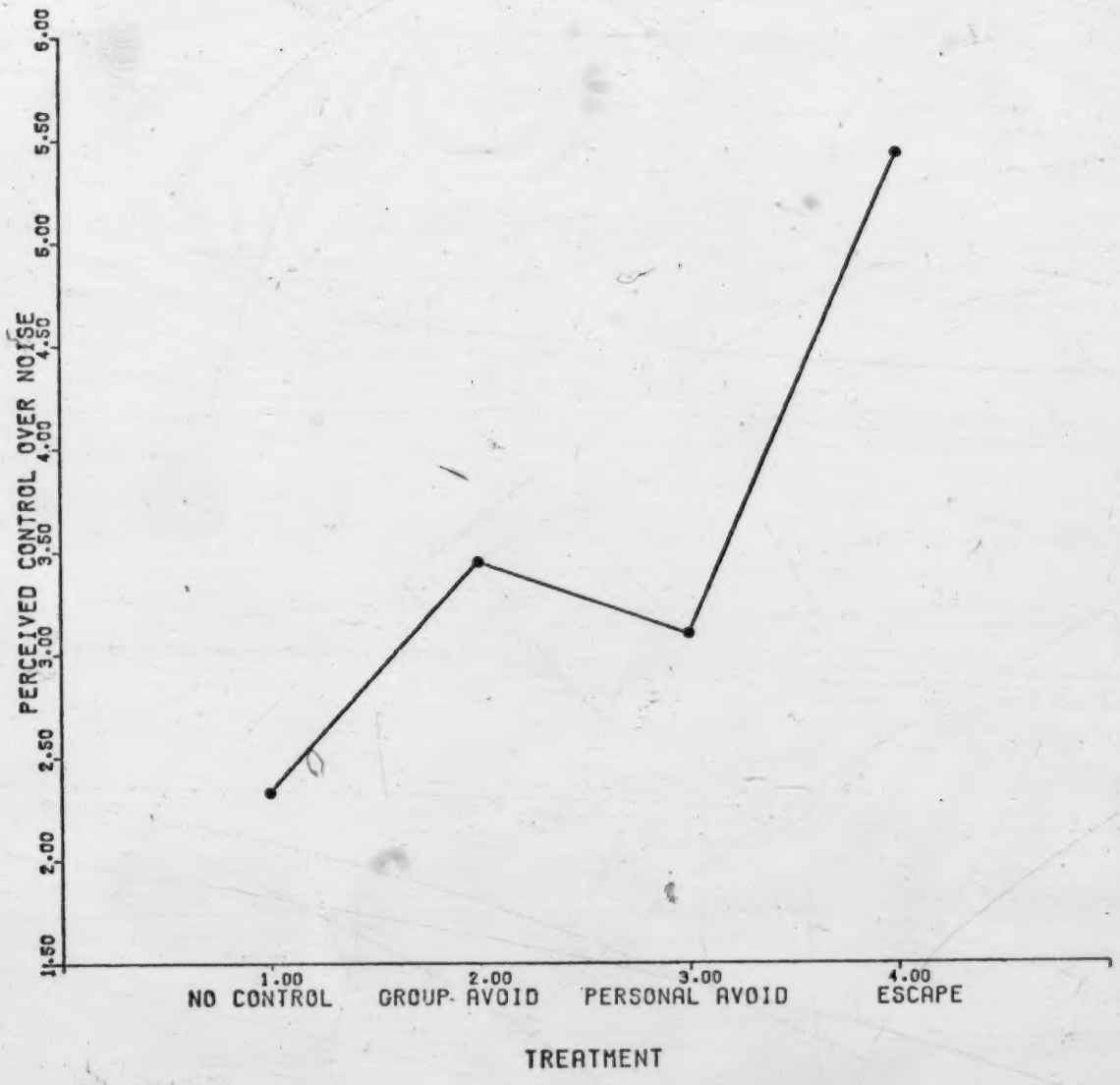

Figure 3. Subjects' ratings of perceived control over noise exposure as a function of experimental conditions.

trials. Thus, the responses of individual subjects remained relatively stable across the six reaction time trials.

Subjective Fatigue

Immediately following the vigilance task, subjects indicated their subjective fatigue on the 13 item Feeling Tone Check List. Analysis of the weighted sum of subjects' responses transformed to a logarithmic scale (Appendix 8), revealed a significant linear trend for control which was consistent with the predicted ordering among the group means ($F=4.56$, df 1/116, $p<.05$). Duncan's Multiple Range Test revealed that no control subjects reported feeling significantly more fatigued than did subjects in the escape condition ($p<.05$).

Noise Annoyance

In order to assess perceptions of overall noise annoyance, a mean catagory rating was derived from subjects' ratings of the 20 noise stimuli. Analysis of these data (Appendix 9) revealed a significant main effect for control ($F=5.93$, df 3/116, $p<.01$), and a significant linear trend in the expected direction ($F=13.87$, df 1/116, $p<.01$). Subjects rated the noise as more annoying as their perceptions of control over noise decreased.

To assess the extent to which subjects may have adapted to the annoying aspects of noise exposure during the vigilance task, mean scores for each subject were derived

for each of 5 blocks of the 4 noise durations. A repeated measures analysis of these data, with perceived control assigned between subjects and blocks of noise trials assigned within subjects, revealed no effect of repeated noise exposure on subjects' perceived annoyance ratings. Thus subjects' ratings of noise annoyance remained relatively stable over noise trials.

Frustration Tolerance

Postnoise performance on the frustration tolerance task was measured by the number of attempts subjects made in solving two insoluble puzzles. Preliminary analysis of these data revealed heterogeneity of the treatment variances, with treatment standard deviations tending to be proportional to the treatment means. Consequently, the persistence measures were transformed to a logarithmic scale which resulted in homogeneous variances. Analysis of the transformed persistence measures for both the combined insoluble puzzle attempts and individual insoluble puzzles, yielded no significant main effect of perceived control. However, the predicted linear ordering among the four control means was supported on the first insoluble puzzle ($F=4,95$, df 1/116, $p<.05$; Appendix 10). The ordering of the means indicated that as perceptions of control over noise exposure increased across experimental conditions, subjects exhibited a tendency to make more attempts at solving the first insoluable puzzle. No significant differences emerged

between control groups on either of the two soluble puzzles.

Post Experimental Questionnaire

Consistent with the view of crowding as a state of psychological stress, the major dependent variables of the study were the questionnaire items pertaining to subjects' perceptions of crowding, comfort, anxiety, enjoyment of the experiment, and perceptions of other group members. Given the exploratory strategy of the present study, both analysis of individual items and analysis of factor scores were performed on the data.

Analysis of the item related to perceptions of crowding failed to support the hypothesis that subjects who perceived more control over their environment would report feeling less crowded. However, a related item, spacious - confined, revealed a marginally significant linear trend which was generally consistent with the predicted ordering among the perceived control means ($F=2.96$, df 1/116, $p<.09$). A post-hoc analysis of this item with the group avoidance and no control groups combined, yeilded a significant linear trend in the expected direction ($F=3.96$, df 1/117, $p<.05$). Thus while the expected relationship between crowding and perceived control was not confirmed, there was some evidence to indicate that subjects viewed the experimental room as more confined as their perceptions of control decreased. These analyses are summarized in Appendix 11.

Analyses of a number of questionnaire items related to subjects' anxiety during the vigilance task, yeilded only a significant linear trend for control on the item, anxious for task to end - not anxious ($F=3.83$, df 1/116, $p<.05$). Comparison of the group means by a Duncan's Multiple Range Test revealed that the no control group rated themselves as significantly more anxious for the task to end than did personal control subjects ($p<.05$). These analyses are summarized in Appendix 12. No other differences were observed.

In addition to the noise annoyance measures collected during the vigilance task, subjects rated their overall level of noise annoyance on the post experimental questionnaire. Consistent with other noise measures, analysis of this item revealed a significant main effect for control ($F=3.29$, df 3/116, $p<.05$) and a significant linear trend in the expected direction ($F=7.25$, df 1/116, $p<.05$). Similarly, a post-hoc analyses of this measure with the no control and group avoidance conditions combined, yielded a significant linear trend for control which was consistent with the predicted ordering among the group means ($F=9.77$, df 1/117, $p<.01$). Thus, as perceptions of control over noise increased, subjects ratings of noise annoyance evidenced a decrease. These analyses are summarized in Appendix 13.

Finally, a post-hoc analysis of the item, cold - hot, (appendix 14) with the group avoidance and no control groups

combined, revealed a significant linear trend for perceived control in the expected direction ($F=4.29$, df 1/117, $p<.05$). Thus there was some indication that subjects who experienced more control over noise perceived the room as more comfortable than subjects who perceived less control over noise exposure. No other significant differences for control were observed for comfort, anxiety, enjoyment of the experiment, or perceptions of other group members.

Factor Analysis

While it was tentatively expected that the results of an analysis of subjects' factor scores would parallel those of the individual item analyses, a principal factor analysis was performed on a number of questionnaire measures. The major purpose of this analysis was to (a) provide convergent validity for the evaluative dimensions characterized by Study I, and (b) to attempt to circumvent the possibility that individual questionnaire measures related to crowding stress may confound both the physical (setting density) and psychological (experienced crowding) dimensions (Stokols, 1976). Thus, a combination of items in terms of their underlying factor structure should converge on the hypothesized concomitants of crowding, and, in addition, enhance the reliability of the measures.

The variables employed in the factor analysis consisted of the 18 items of Table 4 which were taken from the post experimental questionnaire.

The 18 X 18 correlation matrix served as input to a principal factor analysis, PA2, with iteration (Nie, 1974). The squared multiple correlations served as initial communalities estimates. The principal factor pattern was rotated to both an orthogonal (varimax criterion) and an oblique (oblimin criterion) simple structure.

Initial factoring of the correlation matrix resulted in six factors with eigenvalues greater than 1.00 which accounted for 68% of the original item variance. These six common factors were retained in the final solution. The factor patterns for the orthogonal and oblique solutions (Appendix 15) were found to be essentially identical. In both rotated solutions, the same factors emerged, exhibiting nearly identical factor patterns. Similarly, the observed factor correlations for the oblique solution were for the most part negligible. Consequently only the orthogonal solution is discussed. Projections of .40 or greater were regarded as significant for purposes of interpretation.

Examination of the initial factor pattern revealed a general factor to which all items were positively and significantly related, and a number of bi-polar factors. Factor loadings for the first three dimensions of the principal factor solution are shown in Table 5 and Table 6. These three factors were found to account for 41.5%, 20.6%, and 14.5% respectively of the variance accounted for. In general, the loadings on this first factor were so numerous

Table 4

Factor Analysis Item Pool

Variable Code	Variable
QX2	relaxed - tense
QX3	free to move - restricted
QX4	comfortable - uncomfortable
QX5	frustrated - not frustrated
QX6	not stressed - stressed
QX7	self: passive - aggressive
QX8	not anxious for task to end - anxious
QX9	not upset - upset
QX10	not crowded - crowded
QX11	not crowded - crowded
QX12	spacious - confined
QX13	adequate - inadequate
QX14	not stuffy - stuffy
QX15	cold - hot
QX18	others: friendly - hostile
QX19	others: passive - aggressive
QX20	likable - unlikable
QX21	others: calm - disturbing

as to preclude an interpretation other than that of a general comfort factor. Examination of Factors II and III revealed a personal dimension characterized by items related

Table 5

Principal Factor Solution

Loadings for Factor I

Variable	Code	Loading
QX6	not stressed - stressed	.681
QX4	comfortable - uncomfortable	.635
QX5	not frustrated - frustrated	.633
QX10	patient - impatient	.566
QX21	others: calm - disturbing	.550
QX11	not crowded - crowded	.523
QX9	not upset - upset	.513
QX12	spacious - confined	.463
QX2	relaxed - tense	.463
QX3	free to move - restricted	.463
QX20	others: likable - unlikable	.433
QX15	cold - hot	.432
QX8	not anxious for task to end - anxious	.408

to personal comfort, and a social dimension characterized by items related to the perception of others. Thus consistent with the findings of Study I, the unrotated general factor pattern is characterized by a general environmental dimension together with a personal and social dimension. The remaining bi-polar factors had an insufficient number of item loadings for interpretation.

Table 6

Principal Factor Solution

Loadings for Factor II and Factor III

Variable Code		Loading
Factor II (reflected)		
QX12	spacious - confined	.574
QX11	not crowded - crowded	.574
QX14	not stuffy - stuffy	.450
QX7	self: passive - aggressive	-.419
QX5	frustrated - not frustrated	-.409
Factor III		
QX20	others: likable - unlikable	.624
QX18	others: friendly - hostile	.501
Qx19	others: passive - aggressive	.441

Turning to the orthogonal factor solution (Table 7), it can be observed that both the general and the personal factors of the principal factor solution have been broken up into five components, while retaining the social dimension as a sixth factor.

An examination of Factor I revealed a spatial density factor as characterized by items related to perceptions of felt crowding (QX11, QX3, QX4) and items related to perceptions of spatial restrictiveness. This factor, which accounted for 41.5% of the variance accounted for, appeared consistent

Table 7

Varimax Solution Factor Loadings

Variable Code		Loading
Factor I		
QX11	crowded - not crowded	.769
QX12	spacious - confined	.758
QX3	free to move - restricted	.556
QX13	room: adequate - inadequate	.449
QX4	comfortable - uncomfortable	.426
Factor II		
QX8	not anxious for task to end - anxious	.707
QX9	not upset -upset	.617
QX5	not frustrated - frustrated	.592
QX10	patient - impatient	.537
Factor III		
QX20	others: likable - unlikable	.879
QX18	others: friendly - hostile	.689
Factor IV		
QX15	not stuffy - stuffy	.754
QX14	cold - hot	.708
Factor V		
QX6	not stressed - stressed	.755
QX2	relaxed - tense	.559
Factor VI		
QX7	self: passive - aggressive	.737
QX19	others: passive - aggressive	.639

with the spatial density dimension of Study I.

Inspection of Factor II, which accounted for a further 20.6% of the variance accounted for, revealed a personal dimension characterized by items related to anxiety or

stress. Supporting this interpretation was the finding that Factor V, an obvious stress dimension, was moderately related to Factor II in the oblique solution. Factor V accounted for 8% of the variance accounted for by the six factors.

Examination of Factor III and Factor IV, which accounted for a further 14.5% and 9.6% of the variance accounted for, revealed a social density factor and a comfort factor. Social density was indicated by items related to the perception of others (QX18, QX19), while the comfort dimension was indicated by items related to perceptions of the experimental room (QX14, QX15) which reflect physical well-being.

Finally, Factor VI, an obvious aggression dimension, accounted for the remaining 5.7% of the variance accounted for. While the emergence of an independent aggression factor was not expected on the basis of the results of Study I, this factor appeared consistent with the general competitive nature of the vigilance task.

Factor scores

Factor scores for individual subjects for each of the six varimax factors were calculated and analyzed by a single-factor analysis of variance. No significant between group differences due to the control factor were observed for spatial density (Factor I), anxiety (Factor II), social

density (Factor III), comfort (Factor IV), or aggression (Factor VI). However, analysis of the stress factor (Factor V) yeilded a significant main effect for control ($F=2.55$, df 3/116, $p<.06$; Appendix 16). Comparison of the group means by a Duncan's Multiple Range Test revealed that the personal control group exhibited significantly lower levels of stress relative to other experimental groups. In general, these results paralleled those obtained from the analysis of individual questionnaire items.

DISCUSSION

It was evident from the analyses of the items related to subjects' perceptions of control over noise exposure, that the experimental treatment was only partially successful. While the treatment means tended to follow the predicted relationships for perceptions of control, the high level of variability within treatment groups suggested that subjects tended to be distributed in a bi-modal fashion on the control item. Inspection of the relevant data revealed this to be the case. Thus, while response patterns revealed that the perceived control manipulation was successful for the majority of subjects, approximately 20% of the sample failed to exhibit the desired set. More important for the hypotheses of interest however, the manipulation was found to be effective in producing the desired linear relationship among the experimental conditions. Given the exploratory

strategy of Study II, together with the desired linear trend on the control continuum, the perceived control manipulation was felt to be successful. Thus, in general, the control manipulation was effective in mediating a greater degree of perceived control over noise exposure as the experimental conditions ranged from the no control condition to the escape condition.

The primary hypothesis of Study II, that subjects who perceived more control over their environment would report feeling less crowded, was only partially supported. Confirmation of this hypothesis required a decreasing linear relationship between perceived control and perceptions of crowding. However, support for the predicted relationship on the related item, spacious - confined, provides some evidence that perceptions of control over aversive aspects of the environment are effective in mitigating perceptions of spatial constraint.

A number of post-hoc explanations can be offered to account for the absence of stronger crowding effects. First, the potency of the room size factor which was held constant across experimental conditions, may have created a restriction of range effect, which in turn reduced the ability of the perceived control factor to mitigate perceptions of crowding. Thus, the possibility that all subjects felt maximally crowded may have outweighed the effect of perceived control over only one aversive aspect of

the situation; that being aversive noise exposure. Thus, the finding that the crowding mean was found to be consistently high over all conditions (grand mean = 6.65) suggests that levels of perceived control over noise exposure may have been insufficient to depress perceptions of crowding.

A further possibility for the absence of stronger crowding effects is that subjects who perceived themselves as having less control over aversive aspects of the environment, may have expended more effort in attempting to cope with the stressful aspects of spatial constraint. Thus, subjects who perceived lower levels of control may have successfully adapted to crowding, possibly by focusing more attention on the vigilance task. This may have had the effect of depressing levels of perceived crowding for low perceived control subjects relative to subjects who perceived higher levels of control. Support for this possibility is indicated by the finding that subjects' reported subjective fatigue decreased linearly with increasing levels of perceived control. Thus low, relative to high perceived control subjects, may have expended more effort in attempting to cope with the stressing aspects of the crowded environment. Because the present experiment did not manipulate spatial density or the time factor, these alternative explanations cannot be assessed on the basis of the present data.

The finding that increasing levels of perceived control

over noise were highly related to decreases in perceived noise annoyance across experimental conditions, provided a fairly unequivocal test of the assumption that perceptions of control over an aversive stimulus will affect appraisal of the stimulus in reducing its impact. Moreover, subjects' perceptions of control over noise were independent of their actual ability to avoid noise exposure. Thus consistent with the findings of Glass and Singer (1972) and Sherrod (1974), perceptions of control over a social stressor, such as noise or crowding, appear to reduce its adverse effects.

In addition to altering the cognitive context in which stressing stimuli occur, the present findings provide further support for the assumption that perceived control appears to ameliorate the negative behavioral aftereffects of exposure to stressing stimuli. Thus, consistent with findings of Glass and Singer and Sherrod, vigilance task performance in the present study was unaffected by control manipulations. However, increasing levels of perceived control were found to effect increased levels of frustration tolerance on the postnoise frustration task such that low, relative to high perceived control subjects, made fewer attempts at solving the first insoluble puzzle. Thus, while negative consequences of stress emerged on poststress behaviors, these effects were reduced as perceived control over noise increased. Although the relationship is unclear, social stressors do seem to produce negative effects on

performance which may be ameliorated by perceptions of control over the stressor.

Most significantly, the present study appears to extend earlier findings by demonstrating that perceived control over one aversive aspect of the environment may be effective in reducing the impact of other sources of stress in the environment that are not directly controllable, or perceived as controllable. Thus, while subjects in the present study perceived that they had control only in relation to noise exposure, perceived control over noise was effective in mitigating perceptions of spatial constraint. Consistent with the findings of Study I, these results suggest that increasing combinations of stressing aspects of the environment appear to be offset by the relative level of control that is perceived by the individual within the setting. Thus, increasing levels of perceived control, irrespective of the source of this control, appear to be effective in mitigating stress reactions, irrespective of the source of the stress. Further support for this interpretation is provided by the finding that subjects' reported anxiety, as measured by the ratings of how anxious they were for the task to end, exhibited a decreasing linear association with level of perceived control over noise exposure. Subjects who perceived higher levels of control over one aspect of the experimental setting, generally perceived the entire experiment as less stressing.

Finally, the factor analysis of questionnaire responses revealed that subjects' reports of their actual experiences in the environmental setting, exhibited a dimensional structuring that closely paralleled the cognitive-perceptual structure hypothesized in Study I. Thus, the general factor solution of Study II was characterized by three dimensions related to personal comfort, social density, and personal density. Similarly, the domain of salient evaluative dimensions of Study I was characterized by three dimensions related to spatial factors of the environment, social factors, and personal factors related to perceptions of control. Within this framework, perceived control was viewed as central to the evaluative process by which spatial and social parameters are appraised as either stressing or benign. Inspection of Table 5 reveals that the general comfort factor of the principal factor solution, which accounted for the major proportion of the variance in subjects' questionnaire responses, is characterized by social, spatial, and personal factors related to perceptions of stress. Thus as hypothesized in Study I, the relative levels of social and spatial density in the setting appear to interact with personal evaluations to connote relative levels of personal stress or comfort to the individual. In addition to providing convergent validity for the domain of salient evaluative dimensions of Study I, this finding suggests that the individual's experience of the environment

appears to be mediated by their characteristic means of perceiving the environment. Although a number of expected findings were not obtained in this study, in general, the results do demonstrate that the individual's perception of the normative properties of the physical setting is an important determinant of the individual's experience of the setting.

GENERAL DISCUSSION

Taken together, Studies I and II, provide consistent evidence that the experience of crowding appears to be a function of spatial, social, and personal parameters that interact to determine the relative salience of spatial and social density to the individual. Moreover, the results of these studies suggest that the individual's perception of control over the environment appears to be the critical factor that determines the extent to which environmental features will be experienced as stressing or benign. Thus, the individual's perceptions of the environment, together with the cognitive dimensions employed by the individual in organizing perceptions of the environment, appear to determine the manner in which the environment is experienced. These findings are generally consistent with an interactionist perspective which suggests that perceptual and cognitive factors interact with situational factors to determine the response to environmental contingencies.

In the context of crowding, it is apparent that the role of the physical environment in structuring the experience and behavior of the individual is indeed complex. While it can generally be observed on the basis of the present evidence that environmental features, such as spatial constraint, serve as cues to signify to the individual the relative levels of social or spatial density in the setting, it is apparent that cognitive factors may

determine the arousal value of these cues in affecting the response to crowding. Thus, perceptual or cognitive adjustments appear to enhance nonveridical perceptions of environmental cues, which in turn appear to mitigate their perceived threat value. Given this lack of direct correspondence between stimulus intensity and perceived stress, it is not surprising that earlier studies have been unable to confirm the expectation of a direct relationship between density and crowding. Moreover, this relationship is further obscured by the complexity and number of situational and personal factors that may interact to determine a person's cognitions concerning the environment. Thus, while high levels of social density or spatial density may be necessary to predispose the individual to experience crowding, other situational factors may act to reduce the salience of these cues. As a consequence, much of the inconsistent empirical evidence concerning the effects of density and crowding on behavior may be attributed to a lack of a direct correspondence between the relative level of stimulation provided by an environmental stressor, and the amount of stress experienced by the individual.

Initially, the implications of these findings appear problematic with respect to empirical efforts to establish the relationship between antecedent factors of the environment and the experience of crowding. However, the finding that perceptions of control tend to generalize

across sources of environmental stress in mediating the response to environmental contingencies, suggests that environmental factors are related to the phenomenal experience of the environment on the basis of their general arousal raising properties. Thus, previous perspectives have characterized crowding within a motivational framework, such that the individual's inability to modify a specific source of arousal results in a stress syndrome which is directly related to the source of this arousal. Conversely, the present findings suggest that general arousal associated with environmental cues that suggest spatially or socially dense environments, may become labeled as crowding stress depending upon the individual's perceived level of control over the environment. Accordingly, the environmental factors most closely associated with crowding stress are arousal factors related to spatial and social constraint, together with factors that mediate perceptions of control over the environment. Consistent with this interpretation, Epstein and Aiello (1974) have provided evidence that high density or close interpersonal distance can heighten physiological arousal.

Within this framework, individuals are viewed as labeling their arousal state as crowding whenever their arousal is attributed to environmental cues associated with spatial or social density. In turn, perceived arousal will be a function of the relative levels of arousal raising

stimuli present in the environment and the individual's perceptions of control over the environment. To the extent that the individual perceives a relatively high level of control in relation to sources of environmental stress, experienced arousal should remain relatively stable and stress will not result. Conversely, situations which appear spatially or socially dense in combination with low levels of perceived control over the environment, will result in high levels of arousal and may be associated with stress. Following attributional perspectives of Schachter and Singer (1962) and Rule and Nesdale (1977), individuals who are highly aroused by environmental stressors, and who do not have an immediate explanation for their arousal, will label their emotional state in terms of environmental factors. To the extent that environmental cues associated with crowding are perceived as more salient than other environmental cues, either on the basis of their intensity or the situational context in which they occur, the individual is likely to label his arousal state as crowding.

Perhaps the major distinction between current motivational models of crowding and the cognitive labeling model which is advanced here, concerns the extent to which a given environmental stimulus is viewed as causally associated with the experience of crowding. While motivational perspectives have argued for the incorporation into the crowding model of intervening constructs in order

to account for the impact of environmental factors on behavior, for the most part, these models remain rooted within a stimulus-response framework. As a consequence, relatively direct links are postulated between objective conditions of the environment and consequent behavior. Thus, the experience of crowding is viewed as a motivational state directed toward the alleviation of stress associated with a particular spatial variable. Accordingly, drive specific arousal is elicited by a specific stimulus cue, which in turn becomes channeled into specific overt behaviors designed to alleviate the source of this arousal. The most striking contradiction to these assumptions is that the exact nature of these spatial cues have not been clearly delimited. As previously noted, this failure may be attributed to the absence of a direct relationship between the amount of stimulation provided by an environmental stressor and the corresponding level of stress experienced by the individual. Thus, the present findings suggest that environmental cues, rather than eliciting perceptions of crowding, serve to facilitate general arousal which may become labeled as crowding. Moreover, factors which determine the individuals' level of perceived control over the environment appear to be more important in mediating the response to crowding than has been indicated within motivational perspectives of crowding.

Given the foregoing analysis, probably the most

significant implication of the present studies concerns the direction of future crowding research. Specifically, the view that reactions to crowding are jointly determined by cognitive and excitatory reactions to the environmental stimulus configuration as a whole, implies a shift in future research from attempting to identify specific environmental cues that elicit crowding, to an identification of the factors that promote perceptions of control over aversive environmental events. While previous research has implicated environmental needs and motives in sensitizing the individual to spatial constraint, future research must begin to address the questions of how various needs and motives interact with environmental cues to determine the salience of these cues. This implies not only linking specific combinations of environmental arousal to overt behaviors, but moreover, attempting to determine how the relative salience of various cues act to determine response alternatives to the individual. Finally, by focusing more directly upon the dynamic interelations of environment and behavior, future research may begin to uncover the factors that promote adaptive behaviors in response to environmental stressors, rather than maladaptive responses such as crowding stress.

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APPENDIX 1
Experimental Questionnaire for Study I

ENVIRONMENTAL CONCERNS SURVEY

The purpose of this study is to learn what kinds of things in our environment make people feel crowded.

In this questionnaire you will find a number of environmental features or items that may or may not make people feel crowded. These features are simply things like the number of people in a building or the temperature in a classroom. In other words, these are aspects of our environment that we encounter every day and that might affect how comfortable or uncomfortable we feel.

Naturally not everyone will agree that each of these environmental features is equally important for making them feel crowded. The purpose of this survey is to find what types of things make different people feel crowded.

Of course there are no right or wrong answers. We are simply interested in seeing how you personally feel about these things.

Please do not put your name on this questionnaire. Your responses will be held in complete confidence, and will be used for research purposes only. Work as quickly as you can. Do not think too long about your choices but work as accurately as possible.

Your task is to rate the relative similarity of a pair of items in relation to how important you feel each item is for making you feel crowded. In other words, if each item of a pair seems about equal in importance for making you feel crowded, you would rate the items as being similar. On the other hand, if you feel one item of the pair is much more important than the other item, you would rate this pair as not similar.

On the next page you will find a table with a number of items listed across the top and down the left side. Each box in the table corresponds with a pair of items: one item from the row and one item from the column. For example, to find the box for a particular item pair, Temperature and Noise, you would find the column labeled Temperature at the top of the table and the row labeled Noise at the side of the table. The box where the row and column meet in the table corresponds to the pair Temperature-Noise. Your rating for this item pair will be made in this box.

In making your judgments, you will rate each pair of items using a scale ranging from 1 to 9. A rating of "9" would mean both items are extremely similar in importance

for making you feel crowded, while a rating of "1" would mean that the two items are not at all similar in importance for making you feel crowded. A rating somewhere near the middle of the scale would indicate that the two items are moderately similar in importance. Please read the following instructions and rate each pair of items using the scale at the bottom of the next page.

Instructions:

(1) First, look through the list and find two items you feel are about the most similar in importance for making you feel crowded; put a "9" in the box which corresponds with the row and column of this pair.

(2) Second, go through the list again and select the two items that you feel are about the least similar in importance and assign this pair a rating of "1".

(3) Continue rating all the pairs (one item from the column and one item from the row) until each box in the table contains a number ranging from 1 to 9.

(4) You may use the numbers "1" and "9" again if other pairs seem as similar in importance as the initially rated pairs.

(5) There are no right or wrong answers other than what you feel is correct for you.

Rate each pair of items on how similiar in importance you feel they are for making you feel crowded.

	Noise level	Lighting level (dark, well-lighted, etc.)	The number of other people	Number of visual objects (signs, posters, etc.)	Having to interact with others	The length of time you spend in the setting	The type of people (sex, age, nationality)	Temperature	Setting decor (barriers, ant. of furniture, etc.	The difficulty of your activity	Attractiveness of setting (colors, landscaping, etc.)	Type of activity	Your Goal	Setting size
Your familiarity with the setting	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Noise level		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Lighting level (dark, well-lighted, etc.)			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
The number of other people				☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Number of visual objects (signs, posters, etc.)					☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Having to interact with others						☐	☐	☐	☐	☐	☐	☐	☐	☐
The length of time you spend in the setting							☐	☐	☐	☐	☐	☐	☐	☐
The type of people (sex, age, nationality, etc.)								☐	☐	☐	☐	☐	☐	☐
Temperature									☐	☐	☐	☐	☐	☐
Setting decor (barriers, ant. of furniture, etc.)										☐	☐	☐	☐	☐
The difficulty of your activity											☐	☐	☐	☐
Attractiveness of Setting (colors, landscaping, etc.)												☐	☐	☐
Type of activity													☐	☐
Your Goal														☐

1 not at all similar in importance — 2 — 3 — 4 — 5 — 6 — 7 — 8 — 9 extremely similar in importance

PLEASE CHECK THAT EVERY BOX CONTAINS A NUMBER

APPENDIX 2

Instructions for Vigilance Task

General Instructions

Instructions to all subjects were as follows:

This experiment is concerned with the performance of routine tasks under distracting conditions. Specifically, we are interested in finding ways to make jobs such as those of radar operators or air controllers easier to perform by attempting to isolate factors that might result in poor levels of job performance or low levels of job satisfaction.

In this experiment you will be performing a task that is similar in many respects to that of the air controller. You will be asked to monitor a number dial gauges that might be the radar screens of the air controller; listen to distracting noise through earphones much as the air controller must listen to incoming air traffic; and perform this task in a room where the presence of other people might distract you from performing your job.

Specifically, your task will be to monitor these gauges on the walls of the room and push the button of your switch whenever you see that the pointer on one of the gauges moves into the red danger zone. You only need to push the button one time once you have noticed a pointer in the danger zone. After all five of you have pushed the button on your switch the pointer will reset to its normal level. Your task then is simply to watch these gauges and push your button whenever you notice a pointer in the red area. Please keep your switch in the pocket of your lab coat just to ensure that everyone sees the pointer move rather than seeing someone else push a button. Are there any questions?

During the task you will be presented with a number of sounds through your earphones that might sound somewhat annoying. Whenever you hear one of these noises I want you to rate how annoying you find the noise on this scale. For instance, if you feel that the noise you hear sounds vary annoying, you might circle a number on your scale like 6 or 7. Or if you feel the noise you hear is not very annoying at all, you might circle a number on the scale like 1 or 2. Or if you feel that the noise is only moderately annoying you might circle a number in the middle of the scale like 4. Whenever you hear a noise through your earphones I want you to rate how annoying you feel it is by circling one number from 1 to 7 on your scale. Use a different scale for each noise you hear and remember that there are no right or wrong answers, I am simply interested in how these noises sound to you in this work situation. Should you need more scales

simply turn to the next page on your clipboard. Are there any questions?

Escape Manipulation.

In escape conditions subjects received the following additional instruction:
. . . . I am simply interested in how these noises sound to you. Are there any questions?

Now some people find that they do not want to listen to the noise for very long. If you want, you can turn off the noise you will be hearing by unplugging your earphones from your beltclip like this; that is by unplugging your earphones you will end the noise for the remainder of today's session. Of course, whether or not you choose to turn off the noise is up to you. Some people who are in the study do in fact elect to turn off the noise; others do not. We would prefer that you do not, but that's entirely up to you. Are there any questions? Good then we will begin in about 30 sec. and please refrain from talking during the task.

Personal Avoidance Manipulation.

Subjects in personal avoidance conditions received the following additional instruction:
. . . . I am simply interested in how these noises sound to you in this work situation. Are there any questions?

Now some people who come here find that the noise makes it harder to perform the dial monitoring task or that they do not like listening to the noise for very long. As an added incentive to do as well as you can on the dial task, it will be possible to avoid hearing the noise for part or even most of the experiment. That is, if you are able to detect a pointer in the red danger area and push your button within 2 sec. after it moves into the red zone, you will not hear any noise on that particular trial. However if you fail to detect the pointer within 2 sec. the next time a dial moves into the danger zone you will hear the noise again. Whether or not you hear any noise will depend on how quick you are in detecting a dial reading in the danger area. Remember, when you do hear a noise, rate how annoying you feel it is on your scale. Are there any questions? Good, then we will begin in about 30 sec. and please refrain from talking during the task.

Group Avoidance Manipulation.

Subjects in group avoidance conditions received the following additional instruction:
. . . . I am simply interested in how these noises sound to

you in this work situation. Are there any questions?

Now some people who come here find that the noise makes it harder to perform the dial monitoring task or that they do not like listening to the noise for very long. As an added incentive to do as well as you can on the dial task, it will be possible to avoid hearing the noise for part or even most of the experiment. That is if all five of you are able to detect a pointer in the danger area, and push your buttons within 2 sec. after it moves into the red zone, none of you will hear any noise on that particular trial. However, if only some of you detect the pointer within 2 sec., or if any of you fail to detect a pointer the next time a dial moves into the danger zone, you will hear the noise again. Whether or not you hear any noise will depend on how quick you are in detecting a dial reading in the danger area. Remember, when you do hear a noise, rate how annoying you feel it is on your scale. Are there any questions? Good, then we will begin in about 30 sec. and please refrain from talking during the task.

No Control Manipulation.

Subjects in the no control conditions received the following additional instruction:
. . . . I am simply interested in how these noises sound to you in this work situation. Are there any questions?

Now some people who participate in this study have heard from previous subjects that it is possible to avoid hearing the annoying noise by detecting a dial reading in the danger zone within 5 sec. While other groups have been able to avoid the noise by performing at certain levels, that is not possible in this study. In other words, there is nothing you can do to avoid hearing the noise. I just thought I would mention this so that there would not be any confusion caused by something you may have heard about this study. Are there any questions? Good, then we will begin in about 30 sec. and please refrain from talking during the task.

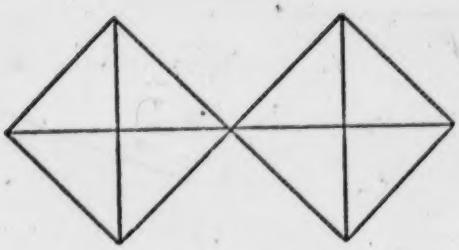
APPENDIX 3

Instructions for Frustration Tolerance Task and Puzzle Diagrams

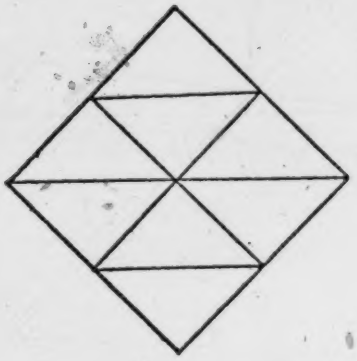
In front of you are four different puzzles. Your task is to trace over all the lines of each of the diagrams without tracing any line twice or lifting your pencil from the figure. If you are unsuccessful, turn the sheet you are working on face down in front of you and pick up a fresh sheet for a new try.

When you have solved a puzzle, or decided that you cannot solve one, go on to the next puzzle. Once you have started a new puzzle you cannot go back and work on previous puzzles. You will have 12 minutes to try and complete all four puzzles. I will tell you when each 3 minutes is up but this is just to help you to judge the time; you may change to a new puzzle or continue working on the same puzzle; this is up to you. Are there any questions? Please begin.

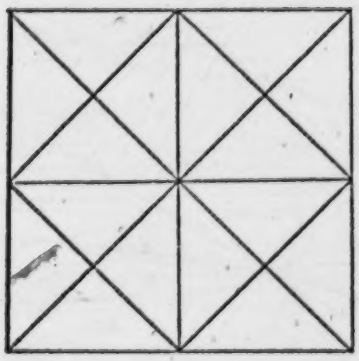
Line Diagrams



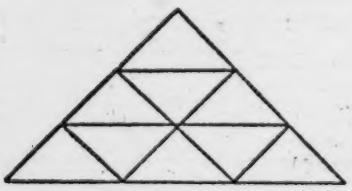
Puzzle 1: Insoluble



Puzzle 2: Soluble



Puzzle 3: Insoluble



Puzzle 4: Soluble

APPENDIX 4

Feeling Tone Check List

Instructions:

While performing this task you may find that you have become somewhat tired or you may feel fresh and ready to continue. We would like to find out how you are feeling right now.

Beside each of the items that follow is a scale which runs from 0 to 10. A 0 means that the statement does not describe your feelings at all, while a 10 means that the statement describes exactly how you are feeling. For each of these items circle one number that best describes how you are feeling right now. Remember there are no right or wrong answers; we just want to know how you are feeling.

No.	Statement											
1.	Slightly tired	0	1	2	3	4	5	6	7	8	9	10
2.	Like I'm bursting with energy	0	1	2	3	4	5	6	7	8	9	10
3.	Extremely tired	0	1	2	3	4	5	6	7	8	9	10
4.	Quite fresh	0	1	2	3	4	5	6	7	8	9	10
5.	Slightly pooped	0	1	2	3	4	5	6	7	8	9	10
6.	Extremely peppy	0	1	2	3	4	5	6	7	8	9	10
7.	Somewhat fresh	0	1	2	3	4	5	6	7	8	9	10
8.	Petered out	0	1	2	3	4	5	6	7	8	9	10
9.	Very refreshed	0	1	2	3	4	5	6	7	8	9	10
10.	Ready to drop	0	1	2	3	4	5	6	7	8	9	10
11.	Fairly well pooped	0	1	2	3	4	5	6	7	8	9	10
12.	Very lively	0	1	2	3	4	5	6	7	8	9	10
13.	Very tired	0	1	2	3	4	5	6	7	8	9	10

APPENDIX 5
Experimental Questionnaire for Study II

This questionnaire contains a number of items which allow you to describe your reactions to this experiment. Your answers to these questions will help us to evaluate the tasks used in this study and to improve the experiment for future subjects. Please read each question carefully and indicate your evaluation by circling one number from 1 to 9. Remember there are no right or wrong answers, we are simply interested in how you personally feel about this experiment. Please be sure that every item contains a circle.

1. Thinking of your previous work experience, was any job you have ever held in any way similar to the dial reading task?

1	2	3	4	5	6	7	8	9
not at all similar								extremely similar

2. On each of the following lettered items, circle the number that best represents how you felt during the dial reading task.

1	2	3	4	5	6	7	8	9
relaxed								tense

1	2	3	4	5	6	7	8	9
restricted								free to move

1	2	3	4	5	6	7	8	9
comfortable								uncomfortable

1 2 3 4 5 6 7 8 9

frustrated not frustrated

1 2 3 4 5 6 7 8 9

not stressed stressed

1 2 3 4 5 6 7 8 9

passive aggressive

1 2 3 4 5 6 7 8 9

anxious for task to end not anxious for task to end

1 2 3 4 5 6 7 8 9

upset not upset

1 2 3 4 5 6 7 8 9

impatient patient

3. How <u>crowded</u> did you feel in the room where you performed the dial reading task?

1 2 3 4 5 6 7 8 9

not at all crowded extremely crowded

4. On each of the following items, circle the number which you feel <u>best describes the room</u> where you performed the dial reading task.

1 2 3 4 5 6 7 8 9

spacious confined

1 2 3 4 5 6 7 8 9

inadequate adequate

1 2 3 4 5 6 7 8 9

not stuffy stuffy

1 2 3 4 5 6 7 8 9

cold hot

5. Overall, how annoying did you find the noise in the dial reading task?

1 2 3 4 5 6 7 8 9

not at all annoying extremely annoying

6. To what extent did you feel you could have had the noise stopped during the dial reading task?

1 2 3 4 5 6 7 8 9

felt I had no control at all over noise felt I had complete control over noise

7. Based on your general impressions, how would you describe the other people who were in this experiment with you?

1 2 3 4 5 6 7 8 9

friendly hostile

1 2 3 4 5 6 7 8 9

passive aggressive

1 2 3 4 5 6 7 8 9

likable unlikable

8. Did you find the presence of others in the experiment had a <u>disturbing</u> or <u>calming</u> effect on your dial reading performance?

1 2 3 4 5 6 7 8 9

calming disturbing

9. Overall, how would you <u>describe</u> <u>this</u> <u>experiment</u>?

1 2 3 4 5 6 7 8 9

enjoyable unenjoyable

1 2 3 4 5 6 7 8 9

boring interesting

10. In general, how <u>frustrating</u> did you find the puzzles task?

1 2 3 4 5 6 7 8 9

not at all frustrating extremely frustrating

11. How many people are there in your immediate family? Include yourself.

_____

(Note: The following pages represent variations of the experimental questionnaire that were received by the avoidance and escape groups respectively.)

---

1 2 3 4 5 6 7 8 9

likable unlikable

8. Did you find the presence of others in the experiment had a disturbing or calming effect on your dial reading performance?

1 2 3 4 5 6 7 8 9

calming disturbing

9. Overall, how would you describe this experiment?

1 2 3 4 5 6 7 8 9

enjoyable unenjoyable

1 2 3 4 5 6 7 8 9

boring interesting

10. In general, how frustrating did you find the puzzles task?

1 2 3 4 5 6 7 8 9

not at all frustrating extremely frustrating

11. To what extent did you feel that your performance on the dial reading task enabled you to avoid the occurrence of some of the noise?

1 2 3 4 5 6 7 8 9

did not at all enable me to avoid some noise

completely enabled me to avoid some noise

12. How many people are there in your immediate family? Include yourself.

_____

11. To what extent did you feel you were completely <u>free</u> <u>to unplug your earphones</u> so that you would not have to listen to the noise during the dial reading task?

1	2	3	4	5	6	7	8	9
not at all free								extremely free

12. How many people are there in your immediate family? Include yourself.

_____

APPENDIX 6

Analysis of Subjects' ratings of Perceived Control Over Noise Exposure

Source of Variation	SS	df	MS	F
Perceived Control	156.97	3	52.32	8.09**
Linear Term	119.71	1	119.71	18.51**
Dev. From Linear	37.26	2	18.63	2.88
Error	750.20	116	6.47	

** $p<.001$

Mean Level of Perceived Control Over Noise

ESC.	G.A.	P.A.	N.C.
5.43^{1}	3.47^{2}	3.10^{2}	2.33^{2}

ESC.: Escape
G.A.: Group Avoidance
P.A.: Personal Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.

APPENDIX 7A

Summary of Analysis of Subjects' Reaction Times for Dial Signal 4

Source of Variation	SS	df	MS	F
Perceived Control	0.32	3	0.11	2.67*
Linear Term	0.06	1	0.06	1.60
Dev. From Linear	0.26	2	0.13	3.21*
Error	4.66	116	0.04	

* $p<.05$

Mean Reaction Time (1/time)

P.A.	N.C.	G.A.	ESC.
0.12^{1}	0.15^{2}	0.22^{12}	0.25^{12}

ESC.: Escape
G.A.: Group Avoidance
P.A.: Personal Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.

APPENDIX 7B

Summary of Analysis of Subjects' Reaction times for Dial Signal 5

Source of Variation	SS	df	MS	F
Perceived Control	0.22	3	0.07	2.94*
Linear Term	0.00	1	0.00	0.00
Dev. From Linear	0.22	2	0.11	4.38**
Error	2.92	116	0.03	

* $p<.05$
** $p,.01$

Mean Reaction Time (1/time)

G.A.	P.A.	ESC.	N.C.
0.12[1]	0.17[2]	0.21[2]	0.23[2]

ESC.: Escape
G.A.: Group Avoidance
P.A.: Personal Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.

APPENDIX 8

Summary of Analysis of Subjects' Fatigue Ratings

Source of Variation	SS	df	MS	F
Perceived Control	0.41	3	0.14	1.86
Linear Term	0.34	1	0.34	4.56*
Dev. From Linear	0.08	2	0.04	0.51
Error	8.60	116	0.07	

* $p<.05$

Mean Log Fatigue Rating

N.C.	G.A.	P.A.	ESC.
2.05^{1}	2.17^{12}	2.17^{12}	2.21^{2}

ESC.: Escape
G.A.: Group Avoidance
P.A.: Personal Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.

Note: Low values reflect greater fatigue.

APPENDIX 9

Summary of Analysis of Subjects' Mean Noise Annoyance Ratings of 20 Noise Stimuli

Source of Variation	SS	df	MS	F
Perceived Control	15.28	3	5.09	5.93**
Linear Term	11.90	1	11.90	13.87**
Dev. From Linear	3.38	2	1.69	1.97
Error	99.55	116	0.86	

** $p<.001$

Mean Noise Annoyance Rating

ESC.	P.A.	G.A.	N.C.
3.42^{1}	4.08^{2}	4.29^{2}	4.29^{2}

ESC.: Escape
P.A.: Personal Avoidance
G.A.: Group Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.

APPENDIX 10

Summary of Analysis of Subjects' Puzzle Attempts for the First Insoluble Puzzle

Source of Variation	SS	df	MS	F
Perceived Control	0.36	3	0.12	1.62
Linear Term	0.34	1	0.34	4.59*
Dev. From Linear	0.02	2	0.01	0.13
Error	8.61	116	0.07	

* $p<.05$

Mean Log Puzzle Attempts

N.C.	G.A.	P.A.	ESC.
0.75^{1}	0.83^{12}	0.85^{12}	0.90^{2}

ESC.: Escape
G.A.: Group Avoidance
P.A.: Personal Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.

APPENDIX 11

Summary of Analysis of Subjects' Ratings of Confinement

Source of Variation	SS	df	MS	F
Perceived Control	5.50	3	1.83	1.41
Linear Term	3.84	1	3.84	2.96*
Dev. From Linear	1.66	2	0.83	0.64
Error	150.47	116	1.30	

* p<.09

Post-hoc Analysis with Group Avoidance and No Control Groups Combined

Source of Variation	SS	df	MS	F
Perceived Control	5.35	2	2.67	2.08
Linear Term	5.09	1	5.09	3.96*
Dev. From Linear	0.26	1	0.26	0.20
Error	150.62	117	1.29	

* p<.05

APPENDIX 12

Analysis of Subjects' Ratings of the Extent to which They Were Anxious for the Vigilance Task to End

Source of Variation	SS	df	MS	F
Perceived Control	19.82	3	6.61	2.01
Linear Term	12.61	1	12.61	3.83*
Dev. From Linear	7.21	2	3.61	1.10
Error	381.77	116	3.29	

* p=.05

Mean Rating

N.C.	G.A.	ESC.	P.A.
5.33^{1}	5.73^{12}	6.07^{12}	6.43^{2}

ESC.: Escape
G.A.: Group Avoidance
P.A.: Personal Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.

Note: Large values reflect less anxiety.

APPENDIX 13A

Summary of Analysis of Subjects' Ratings of Overall Noise Annoyance During the Vigilance Task

Source of Variation	SS	df	MS	F
Perceived Control	28.47	3	9.49	3.29*
Linear Term	20.91	1	20.91	7.25**
Dev. From Linear	7.56	2	3.78	1.31
Error	334.73	116	2.89	

* $p<.05$
** $p<.01$

APPENDIX 13B

Post-hoc Analysis: Overall Noise Annoyance Ratings With No Control and Group Avoidance Conditions Combined

Source of Variation	SS	df	MS	F
Perceived Control	28.05	2	14.02	4.89**
Linear Term	26.78	1	26.78	9.35**
Dev. From Linear	1.27	1	1.27	0.45
Error	335.15	117	2.86	

** $p<.01$

Mean Level of Noise Annoyance

ESC.	P.A.	GA+NC
3.90^{1}	4.73^{12}	5.08^{2}

ESC.: Escape
G.A.: Group Avoidance
P.A.: Personal Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.

APPENDIX 14

Summary of Post-hoc Analysis of Subjects' Ratings of Perceived Comfort: Cold-Hot

Source of Variation	SS	df	MS	F
Perceived Control	8.80	2	4.40	2.62
Linear Term	8.19	1	8.19	4.88*
Dev. From Linear	0.61	1	0.61	0.36
Error	196.40	117	1.68	

* $p<.05$

APPENDIX 15A

Varimax Rotated Factor Matrix

	FACTOR					
ITEM	I	II	III	IV	V	VI
QX 2	.112	.138	.041	.027	.559	.084
QX 3	.556	.198	.079	-.024	.121	.004
QX 4	.426	.193	-.098	.227	.519	.047
QX 5	.013	.592	.252	.069	.369	.225
QX 6	.107	.302	.133	.062	.755	.045
QX 7	-.021	.029	.052	-.091	.341	.737
QX 8	.202	.707	-.090	-.039	.007	-.048
QX 9	-.110	.617	.150	.113	.321	.064
QX10	.131	.537	.114	.045	.351	-.037
QX11	.769	-.044	.053	.192	.146	.028
Qx12	.758	-.004	.129	.172	.037	-.146
QX13	.449	.035	-.047	.109	.028	.031
QX14	.298	.085	-.081	.708	-.007	.020
QX15	.158	.010	.120	.754	.162	.034
QX18	.027	.073	.689	-.047	.034	.178
QX19	-.021	.021	.255	.136	-.010	.639
QX20	.082	.068	.879	.075	.089	.094
QX21	.330	.252	.312	.086	.253	-.014

APPENDIX 15B

Oblique Factor Pattern

	FACTOR					
ITEM	I	II	III	IV	V	VI
QX 2	-.047	.006	.000	.002	.569	.056
QX 3	-.560	.157	.062	.096	.048	.012
QX 4	-.328	.072	-.153	-.180	.490	.041
QX 5	.089	.526	.189	-.058	.240	.186
QX 6	.008	.124	.086	-.032	.749	-.006
QX 7	-.017	-.042	-.064	.125	.294	.758
QX 8	-.149	.767	-.118	.055	-.136	-.029
QX 9	.238	.577	.106	-.128	.213	.026
QX10	-.032	.478	.085	-.028	.264	-.066
QX11	-.757	-.122	.030	-.107	.093	.037
QX12	-.741	-.062	.138	-.093	-.021	-.147
QX13	-.445	.017	-.066	-.062	-.017	.049
QX14	-.135	.075	-.124	-.725	-.095	.017
QX15	.037	-.065	.081	-.782	.098	-.009
QX18	-.027	-.002	.693	.071	-.044	.108
QX19	.006	.028	.173	-.129	-.213	.637
QX20	-.039	-.048	.897	-.050	.000	-.008
QX21	-.268	.163	.301	-.043	.178	-.054

APPENDIX 15C

Oblique Factor Correlations

	FACTOR					
FACTOR	I	II	III	IV	V	VI
I	--					
II	-.187	--				
III	-.073	.191	--			
IV	.356	-.111	-.105	--		
V	-.215	.421	.192	-.177	--	
VI	.056	.053	.262	-.066	.167	--

APPENDIX 16

Summary of Factor Score Analysis for Factor V: Stress

Source of Variation	SS	df	MS	F
Perceived Control	5.32	3	1.77	2.55*
Linear Term	0.33	1	0.33	0.47
Dev. From Linear	4.99	2	2.50	3.58**
Error	80.68	116	0.70	

* p<.06
** p<.05

Mean Level of Stress

P.A.	N.C.	ESC.	G.A.
-0.36[1]	0.08[2]	0.10[2]	0.18[2]

ESC.: Escape
G.A.: Group Avoidance
P.A.: Personal Avoidance
N.C.: No Control

*Means that do not share a common superscript differ significantly at the .05 level by Duncan's Multiple Range Test.